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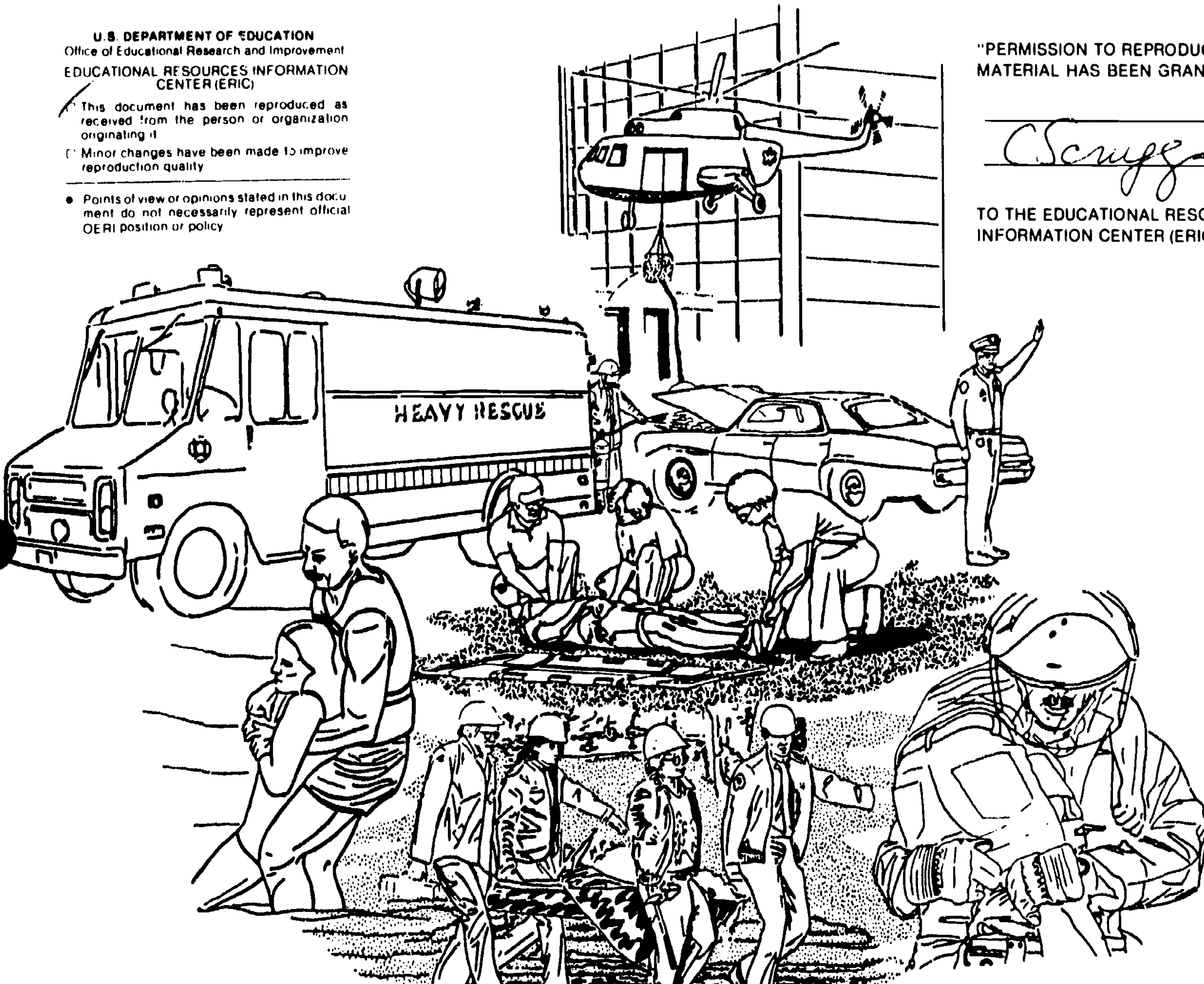
ABSTRACT

This learner manual for rescuers covers the current techniques or practices required in the rescue service. The sixth of 10 modules contains 4 chapters: (1) industrial rescue; (2) rescue from a confined space; (3) extrication from heavy equipment; and (4) rescue operations involving elevators. Key points, an introduction, and conclusion accompany substantive material in each chapter. (NLA)

RESCUE MANUAL



MODULE 6

Industrial Rescue
Rescue From a Confined Space
Extrication From Heavy Equipment
Rescue Operations Involving Elevators

INSTRUCTIONAL MATERIALS LABORATORY
THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO 43210

Edited and distributed by the
Instructional Materials Laboratory
The Ohio State University
College of Education
Columbus, Ohio 43210

Rescue operations may subject both rescuer and victim to the possibility of injury or death. Rescuers must understand the nature and effect of each rescue technique, and practice techniques regularly, using this text to enhance their learning. The materials and information presented here are intended only as a learning aid, and are no substitute for training. Expert opinions, recommendations, and guidelines change as research and experience refine procedures. This text includes the most up-to-date information from rescuers working in the field.

Specialized procedures require demonstration and training by subject-matter experts. It is not likely that a rescuer will become proficient in all rescue operations. Most rescuers develop proficiency in only a few areas but may be familiar with several others.

This text suggests procedures and explains how to do them. The techniques given are guidelines only. Each department should incorporate its own procedures and address local needs.

RESCUE MANUAL

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Rescue From a Confined Space
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Rescue Operations Involving Elevators
Greg Lash, Columbus Division of Fire, Columbus, Ohio

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FOREWORD

The intent of this manual for rescuers is to provide the latest instructional content and serve as an up-to-date, comprehensive source of information covering the current techniques or practices required in the rescue service. To help in this endeavor, an instructor's manual has been developed to be used in conjunction with this learner's manual. The manual has been produced in a series of modules to facilitate future revisions more rapidly and cost effectively.

The instructor's manual follows the key points identified in the text. Chapters have been included in the text which exceed those printed in any other resource. These include managing and operating the emergency vehicle, rope rescue techniques, industrial rescue, farm accident rescue, and various water emergency procedures, among others.

That the rescue profession is a dangerous and challenging career is a recognized fact. It is our hope that this text will help the rescuer meet the challenges of the rescue service in a safe and professional manner.

Tom Hindes
Director
Instructional Materials Laboratory
College of Education
The Ohio State University

PREFACE

The Ohio State Univeısity Instructional Materials Laboratory has played a major role in the training of public safety personnel through the development of text materials for many years. Due to the advances in the rescue techniques, it became apparent that the existing text was obsolete. Upon the advice of many knowlegeable people in the rescue service, the Instructional Materials Laboratory initiated the development of a new text that would be easily updated, and address the needs of the rescuer. To this end, an editorial review board representing a broad spectrum of individuals in the various phases of the research profession was convened to determine what topics this text should address. The culmination of this effort is the Rescue Manual. It is hoped that this text will be useful to not only the new rescuer but will serve as a reference source for the experienced rescuer.

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MODULE 6

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PUBLIC SAFETY SERVICES PUBLICATIONS AVAILABLE

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INDUSTRIAL RESCUE

KEY POINTS

- The importance of preplanning for an industrial emergency
- How an industrial rescue differs from other rescues

INTRODUCTION

Industrial rescue operations require special considerations. Emergencies involving industrial accidents frequently involve a piece of equipment of the following size and capacity. Consider the size and scope of a piece of equipment that is 39′ long, 9′ wide, and 14′ tall, and weighs 264,550 lbs. The fuel capacity is 338 gal. with a hydraulic reservoir of 87 gal. It has a 1000 HP motor and is capable of moving 42 cubic yards of earth at one time. Dealing with a rescue involving this type of or similar equipment in an industrial setting requires preplanning by the rescue department. Rescuers must be aware if such operations are within their jurisdiction.

When responding to an industrial rescue, it is imperative that a rescuer be familiar with the types of potential hazards that may be encountered. It is also important for the rescuer to be familiar with rescue processes used and the layout of the facility. This can only be accomplished through preplanning.

To preplan means to examine and evaluate an industrial facility carefully in advance of an emergency. A facility can be any structure, from a warehouse to a mining or construction site. The information to acquire will vary with the facility, but there are specific details that should always be identified: (1) entry, access, and exit routes; (2) high-risk areas; (3) operational restrictions (fences, barred windows); (4) construction of existing buildings; (5) equipment used in the facility; (6) hazardous materials and processes used; (7) utility meters and shut-off valves such as gas, electric, and water; (8) elevators; and (9) local emergency numbers.

PREPLANNING FOR AN INDUSTRIAL EMERGENCY

The following discussion explains the areas to consider when preplanning response to an industrial rescue emergency. Information in these areas should be written down and kept on file.

Entry, Access, and Exit Routes

How many entrances and exits are in the facility? What type of security is at the facility that may limit access via the quickest route? Rescuers may encounter problems and obstacles getting to some scenes, such as mining or construction sites (see Figure 1). Access can change daily or weekly at construction sites. Any access road may change overnight, creating the need for a four-wheel drive vehicle. Roads created for temporary use are usually very rough, and often weather conditions hamper the rescue evolutions drastically. A helicopter may be required, as well as the assistance of someone who knows the terrain, to lead rescuers into a site. Actual entry into a facility may be hampered by bars attached to window frames, fences, and other security measures. It is also important to be aware of what type of support services are available at the rescue site to help rescuers reach the scene.

Figure 1. Typical Obstruction

High-risk Areas

Will a rescue involve a special process that cannot be shut down easily or quickly? During preplanning, think through procedures and the risks that could be involved. Any situation that may demand special tools, equipment, or resources should be noted.

Operational Restrictions

Are there wires or fences that may hamper operations? Will barred windows have to be removed? List tools and equipment that may be needed.

Construction

How can the construction features of the building assist in the rescue? Items to look for are secure anchor points that can be used if raising or lowering of a victim is required. Also, it is important to know the number of floors and specific construction features found in a facility. In the event of a fire, rescuers must have information about built-in fire protection systems and available water supply; this information should be gathered before an emergency occurs.

Equipment Used in Each Industry

A facility may have heavy equipment such as bulldozers and cranes that may be of assistance in the rescue operations; however, a problem involving such equipment may also be the reason rescuers are called (see Figure 2). The following questions should be addressed. How can the equipment be shut down? How does it operate? How could the equipment trap a victim? Can the equipment be moved easily or is disassembly necessary to perform a rescue? For further information, see the chapter on heavy equipment.

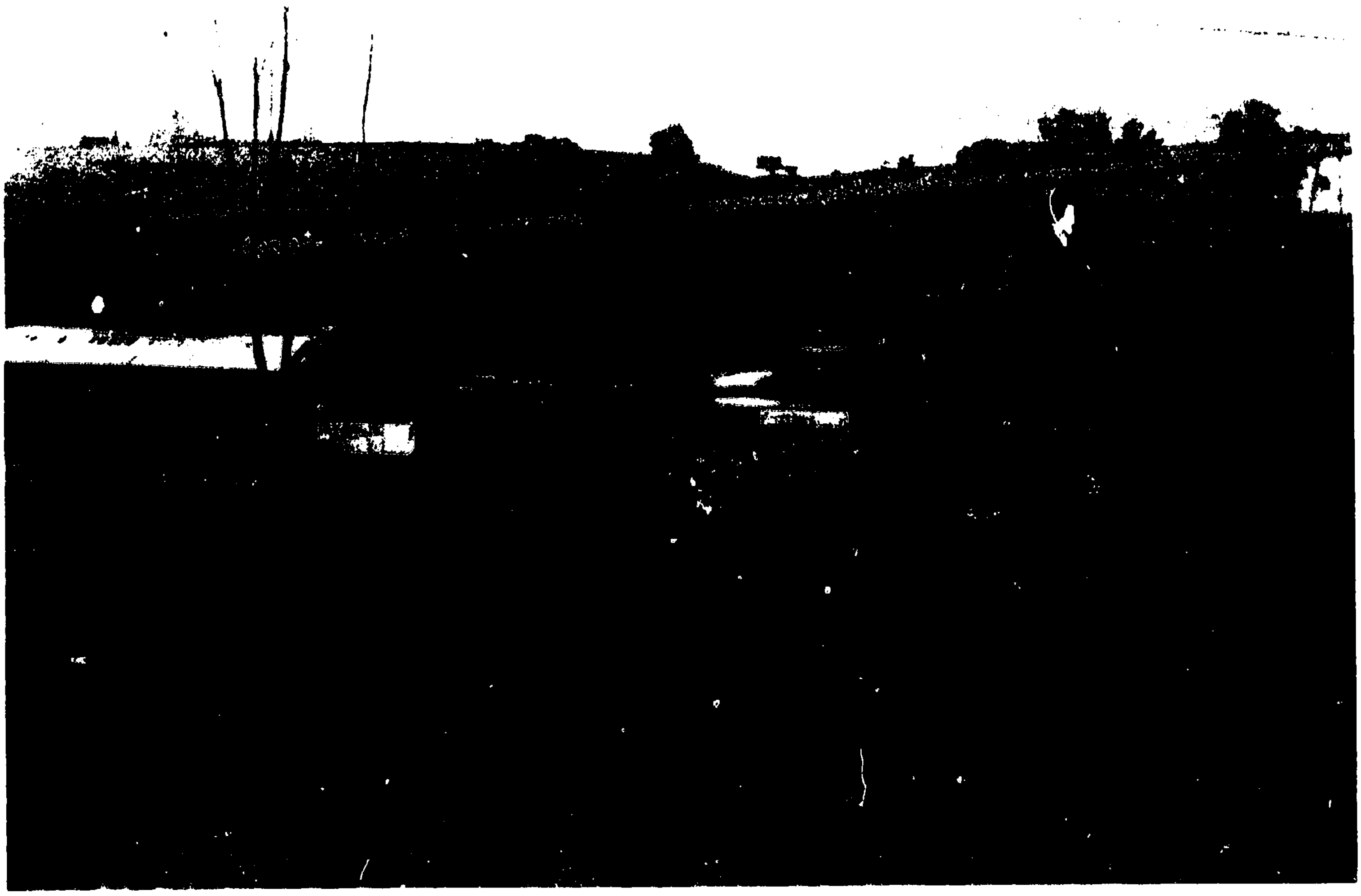

Figure 2. Typical Heavy Equipment

Hazardous Materials

Special rescue procedures may be needed when hazardous materials are involved. During preplanning, identify the types and location of hazardous materials that may be encountered in a facility or surrounding area. Are the materials manufactured or used to make another product within the facility? Rescuers should have a copy of a materials safety data sheet for each material used, or know where the sheets are located in the facility (see Figure 3). Check to see if the buildings, tanks, or storage areas are marked using the NFPA 704M markings or some other markings.

Utilities

Rescuers need to know where the shut-off switches or valves for the utilities are located within the building, facility, or complex. It is also important to know how the utilities are shut down. If specific areas cannot be shut down, how can they be isolated during an emergency?

Elevators

Rescuers need to know information about the elevator system within the facility. The preplan should include names and telephone numbers of elevator mechanics available to provide assistance. See the chapter Rescue Operations Involving Elevators for further information.

Emergency Numbers

Identify the personnel who have special knowledge relating to a facility and the equipment used within. Record the names, addresses, and telephone numbers of these people in case rescuers need to call for assistance. The preplan should also include the names and telephone numbers of local agencies and personnel who can give mutual aid and provide resources during an emergency (see Figures 4 thru 7).

MATERIAL SAFETY DATA SHEET

(Similar to U.S. Department of Labor form LSB-005-4)

SECTION I - SOURCE AND NOMENCLATURE

MANUFACTURER	EMERGENCY TELEPHONE NO.
ADDRESS (NUMBER, STREET, CITY, ZIP CODE)	TRADE NAMES AND SYNONYMS
CHEMICAL NAME AND SYNONYMS	CHEMICAL FORMULA / MOLECULAR FORMULA
INTENDED USES	

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (UNITS)	ALLOYS AND METALLIC COATINGS	%	TLV (UNITS)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER MATERIAL		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUID, SOLIDS, OR GASES					

SECTION III - PHYSICAL DATA

BOILING POINT (°F)		SPECIFIC GRAVITY (H2O=1)	
VAPOR PRESSURE (mm Hg)		PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE	
SOLUBILITY IN WATER			
APPEARANCE AND ODOR			

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED)	FLAMMABLE LIMITS	LEL	UEL
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES			
UNUSUAL FIRE AND EXPLOSION HAZARDS			

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SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE		
INCOMPATIBILITY (MATERIALS TO AVOID)			
HAZARDOUS DECOMPOSITION PRODUCTS			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR		

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

WASTE DISPOSAL METHOD

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE)		
VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (GENERAL)	OTHER
PROTECTIVE GLOVES	EYE PROTECTION	
OTHER PROTECTIVE EQUIPMENT		

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

PAGE (2)

Figure 3. Material Safety Data Sheet

SELF-CONTAINED BREATHING APPARATUS

Item	Phone Number	Masks	Spare Cylinders
30 Minute Pressure-Demand			
Buckeye Fire Dept.	000-598-4525	10	12
Columbiana Fire Dept.	000-387-2800	16	20
Freeland Fire Dept.	000-527-2323	14	25
Kppers Co.	000-527-0110	2	4
Ment Fire Dept.	000-535-1616	4	8
Quaker State Oil	000-387-3530	4	4
Sharonsville Fire Dept.	000-282-3636	17	27
Titanium Metals	000-537-1571	7	4
Trenton Fire Dept.	000-537-1521	6	12
Valley Electric Power	000-537-1506	6	0
Western Steel	000-797-2164	10	25
Westerville Fire Dept.	000-748-3131	7	8
Westerville Co.	000-748-3131	5	10
Westerville Co. #2	000-748-3131	13	24
Westerville Hts. Co. #3	000-748-3131	10	4
Worrensfield	000-283-5439	25	50
Youngsfield Fire Dept.	000-264-1641	13	20
TOTAL		169	257
60-Minute Pressure-Demand			
Freeland Fire Dept.	000-527-2323	2	0
Compressors and Cascades			
Buckeye Fire Dept.	000-598-4525	4CFM	at Station
Freeland Fire Dept.	000-527-2323	SCYL	Cascade Portable
Sharonsville Fire Dept.	000-282-3636	MAIKO	5000 at Station
Trenton Fire Dept.	000-537-1521	4CFM	at Station
Westerville Co. #1	000-748-3131	12CYL 22CFM	Cascade Portable at Station
Westerville Hts. Co. #3	000-748-3131	6CYL	Cascade Portable
Worrensfield	000-283-5439	MAIKO	5000 at Station

Figure 4. Sample Resource List for Emergency SCBA Equipment

FOAM AND ADDITIVES

Item	Phone Number	Gallonage Available
1.5% Foam		
Western Steel	000-797-2164	150 gal
3% Protein and Flouroprotein Foam		
Buckeye Fire Dept.	000-598-4525	100 gal
Cardinal Fire Dept.	000-598-4164	470 gal
Columbiana Fire Dept.	000-387-2800	50 gal
Freeland Fire Dept.	000-527-2323	45 gal
Koppers Co.	000-527-0110	150 gal
Sharonsville Fire Dept.	000-282-3636	30 gal
6% Protein and Flouroprotein Foam		
Western Steel	000-797-2164	300 gal
Westerville C. #1	000-748-3131	10 gal
Westerville Hts. Co. #3	000-748-3131	20 gal
Hi-Expansion Foam		
Buckeye Fire Dept.	000-598-4525	10 gal
Columbiana Fire Dept.	000-387-2800	50 gal
Freeland Fire Dept.	000-527-2323	20 gal
Titanium Metals	000-537-1571	50 gal
Western Steel	000-797-2164	15 gal
Aqueous Film-Forming Foam (AFFF)		
Titanium Metals	000-537-1571	60 gal
Westerville Fire Dept.	000-748-3131	35 gal
Worrensfield	000-283-5439	500 gal
Youngsfield Fire Dept.	000-264-1641	20 gal
Light Water		
Western Steel	000-797-2164	15 gal
Polar Solvent		
Western Steel	000-797-2164	200 gal
No Flash		
Western Steel	000-797-2164	300 gal

Figure 5. Sample Resource List for Foam and Water Additives

SPECIALIZED EQUIPMENT

Item	Phone Number	Units Available	
Ambulances			
Buckeye Fire Dept.	000-598-4525	1 ALS	1 BLS
Ment Fire Dept.	000-535-1616	2 AL	
Westerville Co. #1	000-748-3131		1 BLS
Youngsfield Fire Dept.	000-264-1641	2 AL	
Air Bags			
Clumbas Fire Dept.	000-387-2800	1 set	
Freeland Fire Dept.	000-527-2323	1 set	
Ment Fire Dept.	000-535-1616	1 set	
Western Steel	000-797-2164	1 set	
Acid Suits			
Titanium Metals	000-537-1571		
Valley Electric	000-537-1506		
Western Steel	000-797-2164		
Worrensfield	000-283-5439		
Boats			
Buckeye Fire Dept.	000-598-4525	14-ft JON Boat 25HP	
Clumbas Fire Dept.	000-387-2800	12-ft JON Boat 15HP (2)	
Valley Electric	000-537-1506	16-ft JON Boat 25HP	
Westerville Co.	000-748-3131	22-ft JON Boat 50HP	
Chlorine Kits			
Valley Electric	000-537-1506	A & B kit	
Worrensfield	000-283-5439	A & B kit	
Containment Booms			
Valley Electric	000-537-1506	300 ft	
Hurst Tool			
Clumbas Fire Dept.	000-387-2800		
Freeland Fire Dept.	000-527-2323		
Sharonsville Fire Dept.	000-282-3636		
Trenton Fire Dept.	000-537-1521		
Westerville Co. #1	000-748-3131		

Figure 6. Sample Resource List for Specialized Equipment

HEAVY EQUIPMENT

D.K. Oakes Contracting Company

Daryle Oakes	DAY - 000-264-7731 NITE - 000-264-0654	
Tom Hindes	DAY - 000-264-7731 NITE - 000-735-1205	
Larry Gill	DAY - 000-264-7731 NITE - 000-676-7421	
Dump trucks	10	16 to 20 cubic yards
Backhoes	4	
Bulldozers	4	10' to 13' blades
Front-end loaders	2	3 to 5 yard buckets
Cranes		Truck and crawler cranes Booms (20' to 180') Capacity (25 to 110 ton) Hydraulic truck cranes Booms (30' to 146') Capacity (18 to 80 ton)
Special equipment		Cat winch tractors, winch trucks, Gradalls, backhoe with impactor, truck crane with magnet, jackhammers, clamshell buckets, hydraulic jacks, air compressors, air drills, augers, water pumps, tank trailers

Figure 7. Sample Resource List for Heavy Equipment

Subjects mentioned above are covered in much more depth in other chapters in this module series. See the chapters Incident Command System, Rescue Operations Involving Electricity, and Hazardous Materials for further information.

This information should be gathered prior to an emergency. If rescuers wait until an incident happens to obtain information about an industrial site, rescue operations can be greatly hampered.

RESPONDING TO AN INDUSTRIAL EMERGENCY

Several types of accidents can be encountered in an industrial rescue. To effectively handle an incident involving machines or equipment, rescuers must consider the following items.

Hazard Zone. The establishment of a hazard zone is critical in any rescue operation. The incident commander must identify a restricted area to eliminate the possibility of endangering additional personnel or bystanders. Law enforcement or security personnel may be needed to maintain a safe distance between the rescue operation and onlookers.

Stabilization of equipment. Each piece of machinery or equipment involved in an accident must be stabilized before attempting to extricate a victim. Further injury to the victim and injury to the rescuer may be prevented by stabilizing the machine or equipment before moving or removing any part. See Extrication from Vehicles for more information.

Gaining access. Gaining access to an industrial emergency victim can often be difficult for the rescuer. Standard extrication tools, such as air chisels, gasoline-powered saws, and hand tools, may not be effective when attempting to cut the tubular construction or solid metal construction used in an industrial setting. The strength of roll bars, body and cab components, and the hydraulic equipment of industrial machines may exceed the capacity of the standard rescue tools.

Obtaining a Zero Mechanical State

One of the most valuable resources at the emergency scene can be another equipment operator or a maintenance person who is thoroughly familiar with the equipment involved in the entrapment. Before any rescue procedure begins, it is imperative to make sure the equipment is in a zero mechanical state to prevent anyone from engaging the machine and causing further injury to the trapped individual, or trapping a rescuer. To obtain a zero mechanical state it is necessary to do one or all of the following:

Blank or blind. Provide absolute closure of a pipe, line, or duct by securing with a solid plate or cap capable of withstanding an upstreamed pressure.

Double block and bleed. A confined space can be isolated from a line, duct, or pipe by locking or tagging two closed inline valves, and locking or tagging open a drain or bleed in the line between the two closed valves to the outside atmosphere.

Isolate. Any unwanted form of energy or other agent can be prevented from entering the area by applying a blank, performing a double block and bleed, applying a lockout-tagout, or installing a physical separation.

Linebreak. Linebreaking involves the intentional opening of a pipe, line, or duct that is or has been in service carrying a flammable, corrosive, or toxic material or carrying any fluid at a pressure or temperature capable of causing an injury.

CONCLUSION

It is imperative that the items discussed be considered when responding to an industrial accident. Industrial rescue operations often procedures that are quite different from those encountered by most rescue personnel. The key to a successful industrial rescue is to know before the rescue what may be encountered, and to be prepared to act, using the knowledge gained from training and past experiences.

RESCUE FROM A CONFINED SPACE

KEY POINTS

- **Definition of confined space**
- **Hazards associated with a confined space rescue or entry**
- **Special definitions associated with a confined space**
- **Equipment used in a confined space rescue**
- **The use of environmental monitors in a confined space**
- **Procedures used in a confined-space entry**

INTRODUCTION

A confined space can be large or small, wide or narrow, above or below ground, or mobile or stationary. Such a space is not designed for human occupancy, and natural ventilation within such an area is usually poor. A confined space environment may have any one or a combination of the following undesirable conditions: an extremely hot or cold temperature; dark, damp or slippery surfaces; a poisonous atmosphere; the potential for burns; or loose materials that can fall on a victim. A confined space may also contain machinery that can crush or electrocute.

These statements may sound dramatic, but they are true. Seventy-five percent of the injuries and fatalities victims receive when trapped in a confined space are due to unsafe procedures used either by the person when entering the area or by personnel executing a rescue. The American National Standard Z117.10-1977 defines a confined space as an enclosure having limited means of egress and access. The National Institute for Occupational Safety and Health (NIOSH) describes a confined space as belonging to one of three categories (Publication #80-106).

Class A. A confined space that permits a situation immediately dangerous to life or health is referred to as Class A space. These include, but are not limited to oxygen deficient, explosive, and/or those with a concentration of toxic substances.

Class B. A confined space that has the potential for causing injury and illness if preventive measures are not used, but not immediately dangerous to one's life or health is referred to as a Class B space (see Figure 8).

Class C. A confined space in which the potential hazard would not require any special modification of the work procedure is referred to as a Class C space (see Figure 9).

Figure 8. Class B Confined Space

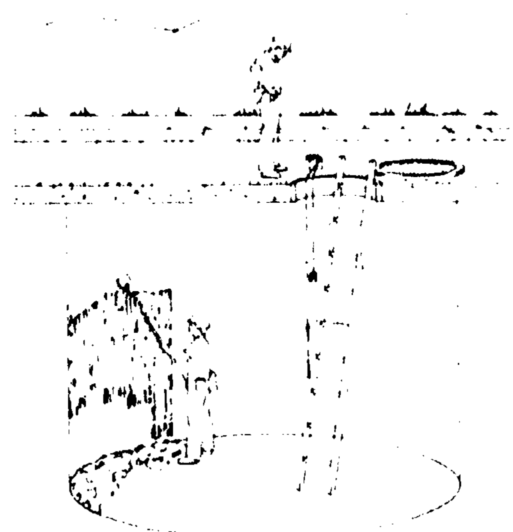


Figure 9. Class C Confined Space

OSHA (Occupational Safety and Health Administration) has written numerous standards addressing problems encountered in a confined space. Examples include the following OSHA standards:

1. 1910.252 (d) (e) (f) General Industry Standard
2. 1926.21 (b) (g) ii Found in the Construction Industry Standard
3. 1915.2 Maritime Standards for Shipyard Employment
4. 1917.2 (e) Maritime Standards for Marine Terminals

Rescuers may consider a confined space as an area with few ways of entry or exit. Confined spaces are areas that are not usually occupied and often contain a hazardous atmosphere or some other identified safety hazard.

Typical confined spaces that rescuers may encounter include the following:

1. Storage tanks
2. Silos
3. Underground utility tunnels
4. Pipelines
5. Boilers
6. Cisterns or tank cars
7. Cable vaults
8. Tunnels
9. Trailers
10. Storage bins
11. Septic tanks or sewers
12. Barges
13. Cable vaults

Hazards associated with a confined space entry and rescue include the following:

1. Atmospheric	4. Electrical
2. Mechanical	5. Chemical
3. Engulfment	6. Physical

Each hazard presents a situation for special consideration as well as the possibility of more than one hazard being present at one time. Before attempting a confined space rescue, it should be assumed that a hazard exists. An analysis of the potential hazards must be conducted to determine a plan of action.

Atmospheric Hazards

Atmospheric hazards, the most common and most dangerous, can be divided into four categories: asphyxiating, flammable, irritant or corrosive, and toxic. Testing for only one or two of the possible hazards may be as dangerous as performing no test at all. Many atmospheric hazards cannot be seen, smelled, tasted, felt or heard.

In an asphyxiating confined space, oxygen deficiency is the initial concern. Normal air contains 20.8% oxygen. According to most safety standards, the minimum safe level of oxygen within air is 19.5%. If the oxygen level drops to 16% or below, the rescuer or the victim may experience difficulty in breathing, a ringing in the ears, drowsiness, and possibly the inability to think clearly. A sense of euphoria may occur. In an oxygen deficient environment a person will lose consciousness and eventually die (see Figure 10). An oxygen deficient atmosphere may be caused

POTENTIAL EFFECTS OF AN OXYGEN-DEFICIENT ATMOSPHERE

Oxygen Content (% by Volume)	Effects and Symptoms (At Atmospheric Pressure)
19.5%	Minimum permissible oxygen level.
15-19%	Decreased ability to work strenuously. May impair coordination and may induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12-14%	Respiration increases in exertion, pulse up, impaired coordination, perception, judgement.
10-12%	Respiration further increases in rate and depth, poor judgement, lips blue.
8-10%	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea, and vomiting.
6-8%	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4-5 minutes, recovery with treatment.
4-6%	Coma in 40 seconds, convulsions, respiration ceases, death.

These values are approximate and vary as to the individual's state of health activity.

Figure 10. Oxygen Deficiency Levels

by the oxidation of metals (rust), combustion, the displacement of the air by an inert gas, or a bacterial action.

Combustible gases can also cause a significant problem within a confined space. Gases may become combustible through a wide range of air mixtures which start at the lower explosive limit (LEL) that provides just enough gas to support combustion to the upper explosive limit (UEL). Above the UEL, there is no longer enough oxygen in the air to support combustion. Combustible gases may be lighter or heavier than air, and constant monitoring of the air is required (see Figure 11).

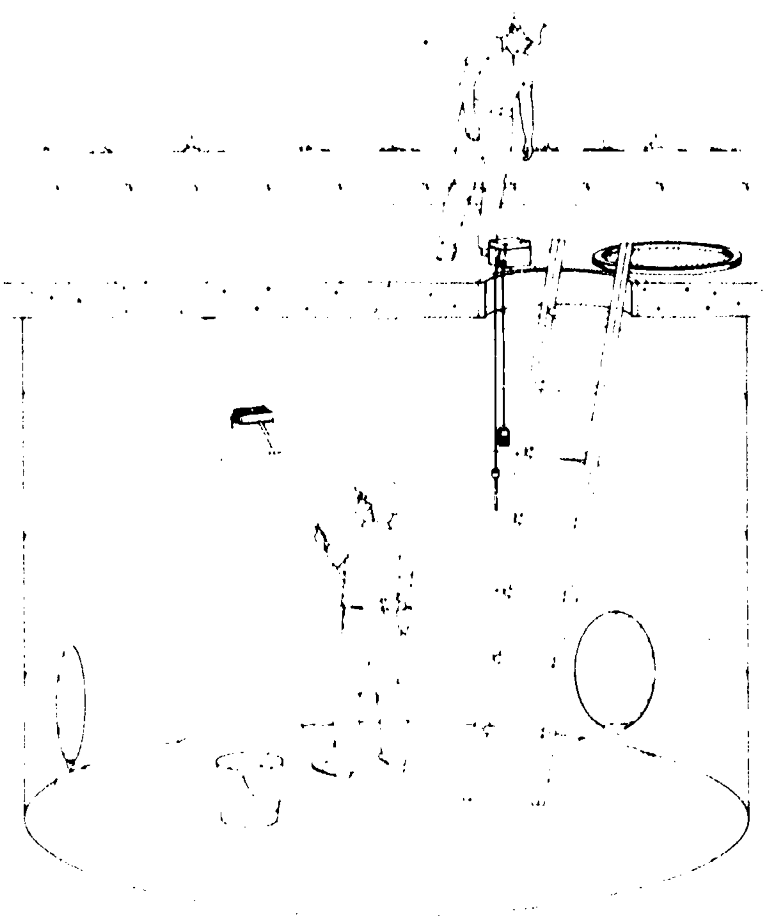


Figure 11. Once Work Begins Monitor Continuously

The third type of atmospheric hazard includes the presence of the toxic gases. Toxic substances can cause injury, irritation, or even death. Those most often found in a confined space include: irritants or chemical asphyxiants. The toxic gases most frequently encountered are carbon monoxide and hydrogen sulfide (see Figures 12 and 13).

Mechanical Hazards

Controlling mechanical hazards refers to keeping out any unwanted energy or potentially hazardous situation such as a mechanical, hydraulic, or pneumatic system. Any machine within a confined space where a rescue is being conducted must be maintained in a zero mechanical state. This can be accomplished by performing a lockout or tagout, blanking, or a double block and bleed on the mechanism.

The confined space must be isolated to restrict any material from entering the rescue area. It is

POTENTIAL EFFECTS OF CARBON MONOXIDE EXPOSURE

PPM*	Effects and Symptoms	Time
50	Permissible exposure level limit	8 Hours
200	Slight headache, discomfort	3 Hours
400	Headache, discomfort	2 Hours
600	Headache, discomfort	1 Hour
1000-2000	Confusion, headache, nausea	2 Hours
1000-2000	Tendency to stagger	1 ¼ Hours
1000-2000	Slight palpitation of heart	30 Minutes
2000-2500	Unconsciousness	30 Minutes
4000	Fatal	Less than 1 Hour

These values are approximate and vary as to the individual's state of health and physical activity.
*PPM - Parts per million; volume measurement of gas a concentration.

Figure 12. Exposure to Carbon Monoxide

POTENTIAL EFFECTS OF HYDROGEN SULFIDE EXPOSURE

PPM*	Effects and Symptoms	Time
10	Permissible exposure level limit	8 hours
50-100	Mild eye irritation, Mild respiratory irritation	1 hour
200-300	Marked eye irritation, Marked respiratory irritation	1 hour
500-700	Unconsciousness, death	¼-1 hour
1000 or more	Unconsciousness, death	Minutes

These values are approximate and vary as to the individual's state of health and physical a activity.
*PPM - Parts Per Million - volume measurement of gas concentration.

Figure 13. Exposure to Hydrogen Sulfide

important to make sure that no machinery moves during a rescue attempt. A zero mechanical state ensures prevention of further entrapment of a victim. It can also prevent the occurrence of another accident (see Figure 14).

Figure 14. Lockout Before Performing a Rescue

Engulfment Hazards

Any loose material such as coal, grain, or plastic pellets stored in a bin may engulf a person entering the bin. This is referred to as an engulfment hazard. Walking on this type of material can cause a person to sink and become fully covered in a matter of seconds. Never enter this type of environment without an SCBA, and a full-body harness with a lifeline attached (see Figure 15). Rescuers must also be aware of the possibility of the formation of a surface crust that appears to be stable but can give way when weight is added. For information, see the Farm Rescue Accident chapter.

Insert Figure 15. Rescuer in Full Protective Clothing

Electrical Hazards

During a rescue involving an electrical hazard, lock the electrical breakers open and tag them out. The person entering the confined space is the person who retains the key. Consideration must also be given to the electrical safety of the tools used in the extrication process. All lighting equipment and tools must be ground-fault protected even if the tools are double insulated. If conditions warrant, use 12-volt, explosion-proof lighting (Refer to NFPA National Electrical Code Class 1, Division 1 Wiring Specifications for details).

Chemical Hazards

Appropriate protective clothing will vary with the chemicals encountered in a confined space. Include major items such as: boots, gloves, acid suits, a full-body harness, wristlets, an air-line respirator with an emergency egress bottle, self-contained breathing apparatus (SCBA), and hearing protection. Each confined space incident encountered will dictate the safety apparel required.

Physical Hazards

Physical hazards will vary with each structure encountered. The entrance may be very small or positioned at a difficult angle. The rescuer may have to be lowered into a space or enter from the top, bottom, or side. The size and shape of the structure, and the problem encountered will determine the plan of rescue action to be taken.

Techniques used in a confined space rescue will vary with the physical constraints of the site, the structure itself, and the materials involved. A thorough knowledge of the rescuer's response area and the equipment available for rescue operations is a must. The safety of the rescuer is a major concern.

Equipment needed will include the following: a full-body harness, safety lines, lowering devices, wristlets, SCBA, a tripod, an A-frame, a Gin-pole, raising techniques (Z-rig or block and tackle), communication equipment, environmental monitoring instruments and ventilation equipment such as smoke ejectors or blowers (see Figure 16). If possible, ventilate an area during rescue procedures to eliminate oxygen deficiency and the accumulation of toxic or combustible gases.

Figure 16. Ventilation Equipment

The best way to ventilate the area is to introduce fresh air at or near the bottom of the space while discharging air at the top. If possible, maintain positive ventilation throughout the confined space at all times. When attempting to ventilate, be careful not to introduce any contaminants such as exhaust fumes from nearby vehicles.

CONCLUSION

Confined space rescue operations must be handled with the utmost respect. Never proceed with any rescue procedure before checking the lockout, isolating the space, and maintaining a zero mechanical state of all involved equipment. Always monitor the confined space environment, and wear protective clothing including a SCBA, a full-body harness, wristlets and safety lines. It is important to provide for the safety of all rescue personnel as well as that of the trapped victim.

EXTRICATION FROM HEAVY EQUIPMENT

KEY POINTS

- The specialized design of heavy equipment
- Hazards encountered at sites where heavy equipment is used
- Responding to and assessing the emergency
- Hazard control at the site
- Removing a victim from heavy equipment
- Dealing with a train accident

INTRODUCTION

Industrial activity often requires a complex assortment of machinery. Heavy equipment is often complex in construction, and usually performs specific operations. Specialized training is often required to become proficient in its operation. Such equipment can be found in industrial complexes, at strip mines, at building construction sites, and along the highway during maintenance and construction projects (see Figures 17 and 18).

Since most equipment used in industry is powerful, and operating it requires special training, there is always the potential for accidents and injury to operators as well as to nearby workers. Equipment is often operated on unstable surfaces, which increases the possibility of cave-ins, turnovers, or collapses. Most pieces of equipment have built-in safety devices; however, operators are often neglectful and the devices are not used. Operators who are unfamiliar with the equipment, or use a piece of equipment for a task that is greater than its capability are the most common causes of accidents.

Rescuers must be familiar with the special problems of accidents involving heavy equipment. Specific hazards must be dealt with individually. Special techniques and improvisations must often be used when there is a call for a rescue.

HEAVY EQUIPMENT DESIGN

Heavy equipment is designed to perform many complex operations, such as carrying, lifting, pushing, or pulling heavy loads. Gasoline- or diesel-powered engines are used to power heavy equipment. To provide engine efficiency, each piece of equipment has a large fuel tank; thus, when and accident occurs the large amount of fuel and other flammable liquids often pose a hazard to the rescuer. Other potential dangers include moving shafts, gears, and cables.

Figure 17. Specialized Heavy Equipment

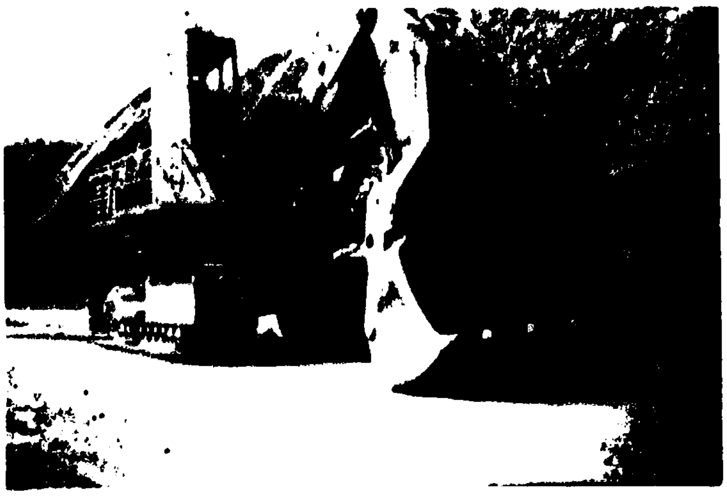


Figure 18. Specialized Heavy Equipment

Heavy equipment operators are usually seated in an enclosed cab (constructed of heavy-gauge metal) that provides very close quarters for the operator (see Figure 19). In the event of an emergency, this heavy construction may pose a problem for the rescuer, since conventional vehicle extrication devices will not cut this heavy metal. When it is necessary to cut the metal, cutting torches or exothermic devices may be needed. Some equipment cabs have glass mounted in a rubber channel on all four sides, while other cabs are open; construction companies, especially road crews and general contractors, often use equipment with open cabs. If an operator handling equipment with an open cab is not wearing a seat belt, it is likely the operator will be ejected from the vehicle in the event of an accident.

Figure 19. Operators Enclosed Cab

Bulldozers

Bulldozers are made in a variety of sizes, from small lawn devices to mammoth earth movers (see Figure 20). The average size of a small dozer is 10′ high, 10′ wide, and 16′ long. The average size for a large unit is 14′ high 18′ wide, and 40′ long. The weight usually ranges from 14,500 to 265,000 pounds. The engine capacity ranges up to 1,000 horsepower, and fuel supply ranges from 65 to 340 gallons.

Figure 20. Bulldozer

Front Loaders

Large front loaders, commonly found in the strip mines or at excavating sites, are used for loading trucks. The front loader is designed to hydraulically swivel on the base (see Figure 21). The average front loader is 29′ high and 43′ long, weighs 200,000 pounds (100 tons), and has a fuel capacity of approximately 310 gallons.

Figure 21. Front Loader

Trucks

Trucks used at construction sites range from pickup trucks to earth movers capable of carrying 175 tons (see Figure 22). A large truck used at an earthmoving operation is typically 14′ high; with the dumping unit fully extended it becomes 27′ high,

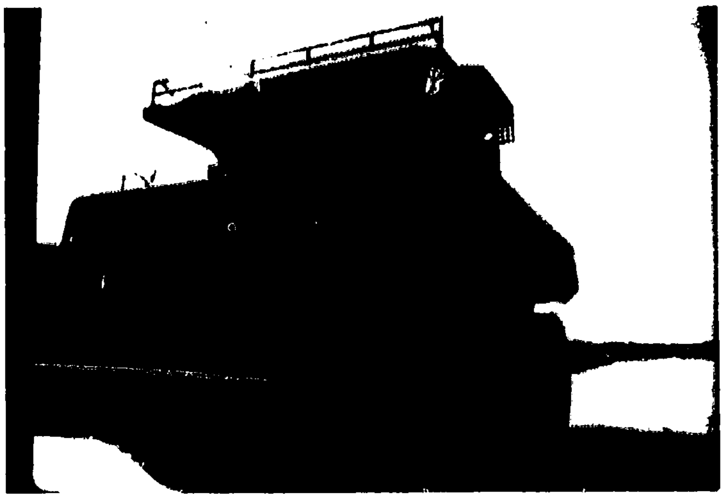


Figure 22. Earth Mover

12′ wide, and 20′ long. This type of truck has a fuel capacity of approximately 180 gallons and usually weighs 20,700 pounds when empty.

Draglines

Mammoth draglines designed to move large quantities of earth are used in many parts of the country (see Figure 23). This type of machinery is constructed to sit on a moving platform that allows it to "walk" and advance itself. The unit is self contained and is electrically operated by a 10,000 volt umbilical line. The body of the machine encloses the electrical motor that rotates the body and provides power to the winch equipment that operates the bucket (see Figure 24). The gantry of this unit stands approximately 130′ above ground level.

Figure 23. Dragline

Figure 24. Electrical Motor Enclosed in a Dragline

Most rescue operations performed in the dragline will involve a rescue from a confined space within the platform, a rescue from the equipment and structures within the body, or a high-angle rescue from the tower or gantry. In the event of a dragline accident, elevated winch equipment is available in the body to lower a victim (see Figure 25); however a victim injured while in the gantry will have to be lowered by rescuers using ropes.

Figure 25. Winch on a Dragline

Specialized Equipment

In addition to bulldozers, front loaders, and trucks, many other types of equipment are found at construction sites (see Figure 26). Specially designed equipment is made to perform specific construction operations, such as scraping a road, lifting topsoil, laying pipe, or drilling a hole for explosives. Most of this equipment is constructed and operated similar to other equipment used for heavy construction. The hazards are similar for all heavy equipment. Supervisors and equipment operators at the site are usually good sources of information concerning the equipment and its operation when a mishap occurs.

Figure 26. Specialized Equipment

SPECIAL HAZARDS

Deal with all hazards according to priority. Stabilization may be the biggest problem and it may be necessary to use winches, cranes, or air bags. Flammable liquids are often present, so it is important to shut off the engine as soon as possible and be watchful for high temperatures and fire hazards.

Terrain and Access

An accident that occurs in an industrial situation often poses special problems to rescue personnel. At many industrial sites, roads leading to a given area of the plant may be inaccessible to rescue trucks, ladder companies, and other needed equipment. Roads may be blocked due to plant operations or to a train on railroad tracks that enter a plant. If roads are blocked, supervisory personnel must be consulted as soon as possible to find an alternate route of entry. Preplanning can be very helpful in the event an industry has such obstacles.

In urban areas traffic may be rerouted around a construction sites or access to the site may be totally blocked. In such incidents, law enforcement agencies must be asked to assist in gaining access to an accident area.

In a rural area heavy equipment is most commonly used in surface mining operations. Heavy equipment is used to remove topsoil, remove underlying coal and minerals, and return the topsoil to reclaim the land. Access to such areas is usually via temporary dirt roads (see Figure 27). Preplanning is impossible since a road built for an immediate need is often gone within a few months.

Figure 27. Temporary Dirt Road

Responding to the incident may be difficult due to unstable terrain. Four-wheel drive vehicles may be required for entry or exit. Upon arrival at the scene, assess the situation, evaluate resources available at the scene, and if special equipment is needed, request it an soon as possible.

Arrangements must be made at the time the emergency equipment is dispatched to have someone meet the rescuers and lead them to the accident scene. Getting to the scene may prove to be difficult since access may be over loose, freshly turned, unsettled soil. A four-wheel drive vehicle is often available at the site to assist in transporting the rescuers and equipment.

Electrical Accidents (High-Voltage)

In a surface mine operation, some equipment is operated by high-voltage electric motors. Umbilical lines and electrical substations (see Figure 28) are found at the site. Care must be taken to avoid such equipment. If an accident involves equipment that uses high voltage, attempts must be made to have the power shut off immediately.

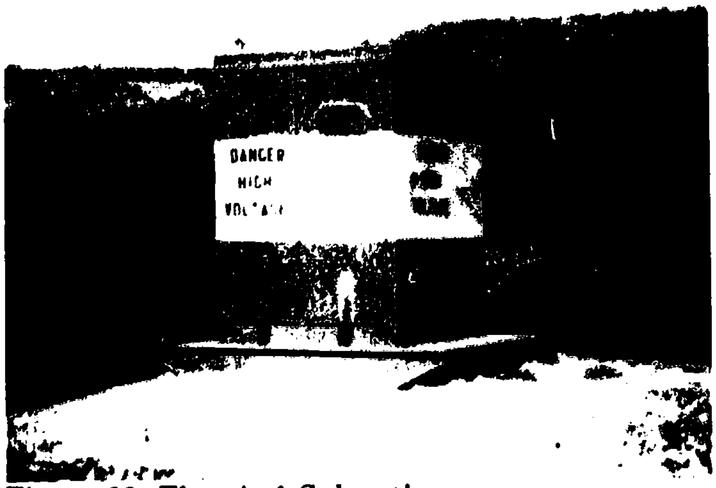


Figure 28. Electrical Substation

In an industrial setting, when an accident involves electrical equipment, shut off all power and employ lockout techniques to ensure that the power will not be restored (see the module on rescue operations involving electricity). OSHA requires specific guidelines be followed when performing lockout techniques. This task should be done by official plant personnel if they are available.

Hazardous Materials

In many industrial operations, various types of hazardous materials are used. When an incident involves a hazardous material, specific precautions must be followed prior to performing the rescue. (For further information see the chapter hazardous materials).

Due to the size of heavy equipment, a significant quantity of oil, diesel fuel, and hydraulic fluid is always present. These fuels present specific hazards. If an accident has damaged any of the fuel storage, measures must be taken immediately to control leaks and spillage. Many heavy equipment operations are dependent on hydraulic operations. Damage to the hydraulic system causing a leak may allow the parts to move and cause further injury. Any time rescue operations are close to hydraulically-operated machine parts, shore and stabilize the parts prior to the rescue.

In a surface mine operation, explosives are used to loosen the ground. Trucks carrying explosives may be found along face operations (see Figure 29) along with trucks specially designed to carry and load blasting agents. When any of these vehicles are involved in an incident, procedures for handling explosives must be followed and a hazardous materials team must be called to the scene.

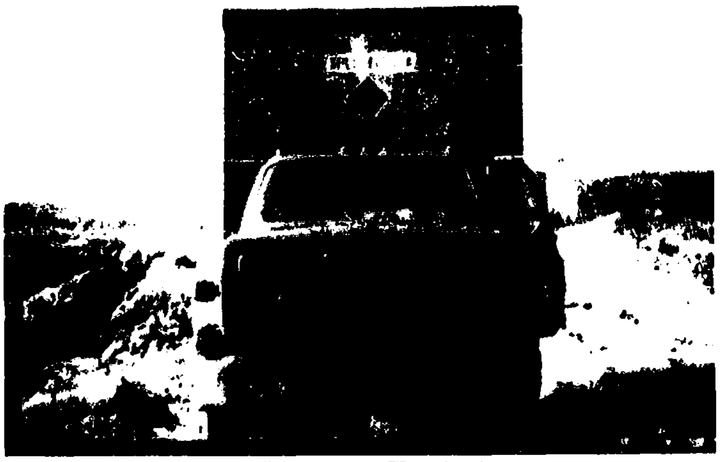


Figure 29. Truck Carrying Explosives

Shoring and Stabilization

As with all vehicle accidents, the involved equipment or vehicle must be stabilized prior to starting rescue operations. The underlying soil may be loose and wet; thus not providing a firm base on which to perform the rescue. The equipment is often very heavy and may pack the ground underneath it. Stabilization may be accomplished by using cribbing, air bags, winches, or other heavy equipment. Considering the size and configurations of the equipment, shoring often poses a problem.

Most rescue units do not have large quantities of cribbing on hand. Make arrangements to have heavy timbers brought to the scene if shoring material is not readily available. Care must be taken to assure that the cribbing is on a base adequate to support the weight of the machine. Air bags may be used in conjunction with cribbing to assist in the stabilization. Rescuers must establish as many points with the ground as possible to stablize the equipment. The incident commander must be assured that all equipment is stable before proceeding with the rescue.

INITIAL RESCUE PROCEDURES

Response

Responding to a heavy equipment incident often poses unique problems. Routes and alternate routes of travel must be established. Meet with someone from the industrial site to lead the rescue unit to the scene to avoid unnecessary delays. The dispatcher should confirm this arrangement during the initial call for assistance.

Assessment

Upon arrival the incident commander must make a rapid assessment of the situation. This assessment must include the type and size of equipment, its position and stability, and potential hazards involved. An assessment of the rescue equipment that will be needed and its availability must be determined. All rescue units should have a resource listing that details equipment and gives a telephone number and a contact person for each item. This listing should include access to a crane, a wrecker, air bags, and cribbing material.

Call for an adequate number of rescue personnel and equipment immediately. If necessary, establish a staging area. The incident commander may want to recruit the assistance of company supervisors, mechanics, and equipment operators in the rescue procedures since these people are experts in their field and can be a valuable resource.

HAZARD CONTROL

High Operating Temperatures

Most heavy equipment operates at a high temperature. The operating temperature plus that of the environment often causes the body of the equipment to become very hot. This may pose a problem to rescuers working with or operating the equipment. Always wear turnout gear and use blankets for protection when working on or near warm equipment. If necessary, a hoseline may be used to cool the metal; however, the water runoff from this hoseline must be contained to avoid softening of the ground that might jeopardize the stability of the rescue operation.

Flammable Liquids

Heavy equipment operates with a significant volume of flammable liquids, such as diesel fuel, oil, and hydraulic fluid. Always keep a hoseline along with other fire extinguishing agents such as CO2 and foam readily available. If leakage of any fluids occurs, the leak must be stopped and the spill contained. Most of these liquids are irritating to the skin, and if skin contact is made, proper care must be taken to prevent skin damage.

Ignition Sources

Due to the flammable liquids found in heavy equipment, fire is always a concern, and all ignition sources must be controlled. Turn the ignition key to the off position on a gasoline-powered engine. If the engine is diesel-powered, pull the shut-off handle and turn the on/off switch found in the operator's compartment to the off position (see Figure 30.) If necessary, inject CO2 into the air intake of the engine to shut off the engine.

Figure 30. Engine Shutoff

REMOVING A VICTIM

Several methods can be used to remove a victim from the operator's cab. Usually the victim will have to be removed from an elevated position.

Access to Operator Compartment

The compartment for a heavy equipment operator is usually elevated so that the operator can have a good view of the ground. Gain access to a victim through the most accessible route. This may require improvisation. Rescue tools, especially exothermic and cutting torches, may be required to execute an effective rescue. Each compartment has a narrow ladder leading to the cab. When operating near the cab, for the rescuer's safety it may be necessary for the rescuer to tie off with a truck belt. Many vehicles have a roof ladder that will enable a rescuer to work to the left of the operator. On this type of vehicle remove the hand rail to gain access to open the door. Access around the compartment is usually very narrow and rescuers must be cautious to keep from falling.

The windows are usually set in a rubber channel and the glass can be removed easily by cutting the lip of the channel and lifting the glass in one piece. Many road construction vehicles have open compartments, so access is not a problem.

Disentanglement

Due to the size and sturdiness of heavy equipment, disentangling a trapped victim may be difficult. The easiest method of disentanglement may be disassembly. Mechanics on the site may be helpful in providing advice, tools, and assistance in disassembling a piece of equipment. Once the victim is disentangled, lower the victim to the ground and prepare for transport. If disassembly is impossible, cut away the heavy metal, using cutting torches, exothermic cutting tools, or a rescue saw.

Care of the Victim

Once a victim is accessed, conduct primary and secondary assessments and administer emergency care. Due to the shape of the operator's seat and the close confinement of the compartment, it is usually necessary to use a standard extrication device to immobilize the operator. Place this device on the victim in the usual manner. Once immobilized, remove the victim from the compartment to a long backboard or a Stokes stretcher, strap him or her on to the device, and apply a footrest. For further information see chapter on patient care and handling. The victim is now ready to move.

Ladder Slide

The simplest and most practical way to remove a person from a high truck cab is to place a ladder (usually a 14′ ladder) up to the operator's compartment. Take a backboard up to the compartment and secure the victim to the board. Place a rope through the top handholds of the backboard and tie it with a bowline. Then, lift the backboard onto the ladder. Secure the backboard and slowly slide it down the length of the ladder (see Figure 31). A second rescuer (above) should walk down the ladder as the rope and ladder (with the victim) are lowered.

Figure 31. Ladder Slide

Descending Device

When working with a large truck or a front loader, the confinement of the victim and the distance from the ground are usually too great to use the ladder slide. In situations of close confinement, it is easier to lower the backboard without the ladder. Using a wire sling and carabiner attached to the holes in the structure of the roof, attach a figure-eight descending device to the roof. Pass a lifeline rope through the descending device and attach it to the top of the backboard with slings. Apply two guy ropes to the bottom of the backboard. The use of two ropes gives added stability. Then lower the victim to the ground, controlling the descent with the friction device (see Figure 32). (For further information see the chapter on rope rescue.)

Figure 32. Using a Descending Device

Ladder Hinge

The ladder hinge device is recommended when it is necessary to remove a victim from a large front loader. Once the victim is placed on a backboard, place the board across the seat and place an extension ladder on the ground, perpendicular to the equipment. Attach two lifeline ropes to the top rung and beam of the ladder with a ladder hitch or split-clove hitch. Pass one part of each rope to the operator's compartment and use the other part of each rope as a guy line. Raise the ladder so that the second rung is higher than the backboard and is locked into place.

Attach the backboard to the second rung of the ladder with slings. Then attach the ropes to the end of the backboard by placing a figure-eight knot in each rope loose enough so that slack is present. Place a short sling in each rear handhold and attach to the knots with carabiners. With tension on the guy ropes, lower the ladder; control the victim's descent with the two support ropes (see Figure 33).

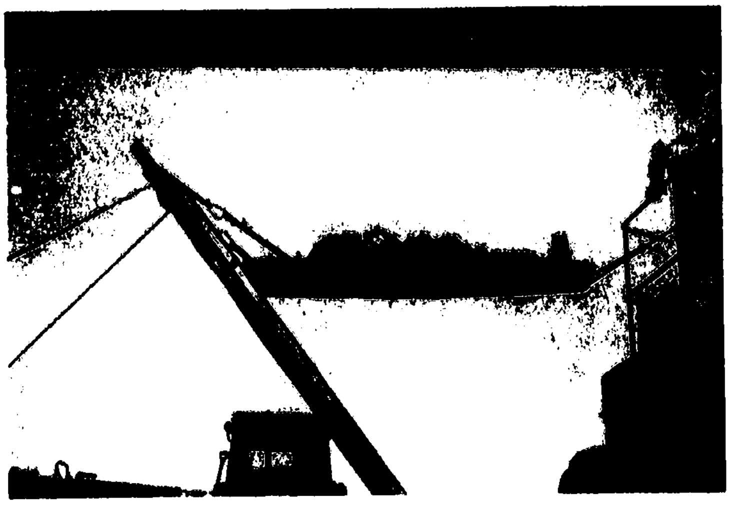


Figure 33. Ladder Hinge

Further Victim Assessment

Once the victim is moved to the ground, a more thorough assessment of his or her condition can be done, and basic and advanced life support can be initiated. The victim may have to be moved via a four-wheel drive vehicle if he or she is in an area that is difficult for the rescue vehicle to access.

ROLLOVER OF EQUIPMENT

In the event of heavy-equipment rollover or a collapse where a victim is trapped underneath, determine the capacity of the rescue equipment available. If extra equipment is needed for lifting request it immediately.

Stabilize the rolled vehicle. Due to the size and weight of the equipment, material used for vehicle shoring is usually ineffective. Heavy shoring materials, timbers, cranes, and air bags may be needed to execute a safe rescue. Trucks or other pieces of equipment used by company personnel are usually available at the site and have the capability to lift heavy equipment. The most experienced operator must be the person to operate the equipment.

During the raising procedure remove all unnecessary personnel from the area. Lift the vehicle only enough to perform the rescue. As the vehicle is lifted, place cribbing underneath the vehicle to support it to prevent further injury to the victim during extrication.

TRAIN ACCIDENTS

Another type of heavy equipment encountered is the railroad train. Trains travel through many areas and the potential for a train accident exists nearly everywhere in the country.

Because of the complexity of a train accident, an incident command system must be established upon arrival at the scene and all rescue sequences followed. Before proceeding with the rescue, determine if any hazardous materials are present. Shipping papers (waybills) can usually be found with the engineer in the engine, or the conductor in the train's caboose. Railcars are required to post a placard when carrying hazardous materials.

Depending on the size of the train, several different types of railcars may be found at the site. Locomotives usually have a capacity of 3600 horsepower each with a diesel engine that powers an electrical generator capable of producing 2.5 million watts of power to each engine.

During any incident involving a locomotive, the engine must be shut down by means of the three emergency shut-off switches found on the engine. One switch is located on each side of the locomotive above the fuel tank (see Figure 34) and one on the electrical panel in the cab directly behind the engineer (see Figure 35). These switches control the fuel supply to the engine.

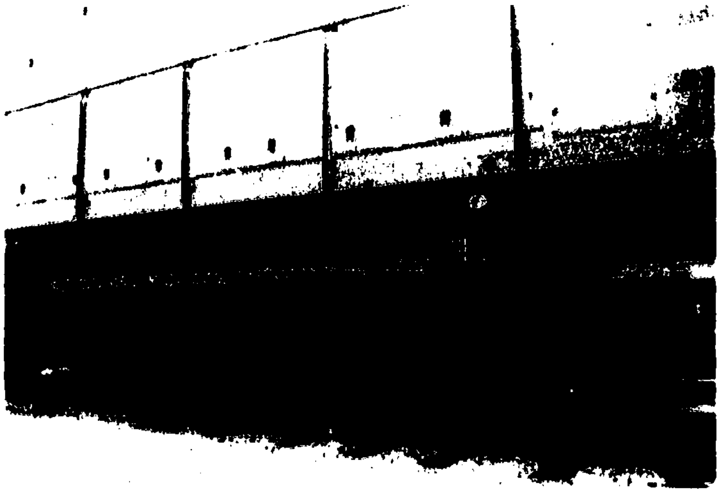


Figure 34. Emergency Shut-Off Above Fuel Tank

Figure 35. Emergency Shut-Off in Cab

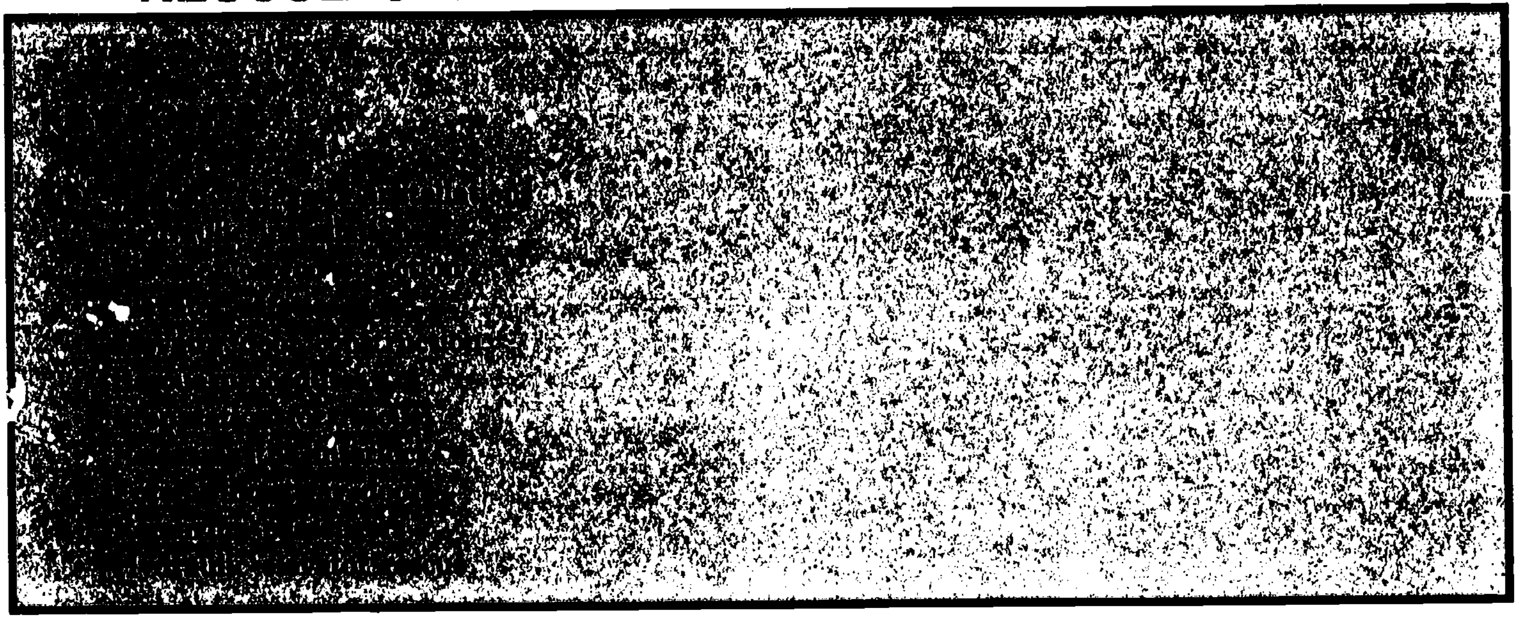
Once the engine is shut down, the battery supply must be disconnected. Usually, the battery-system switch is located inside the electrical panel behind the engineer. Once the disconnections have been completed, all electrical power is interrupted.

A locomotive carries approximately 4000 gallons of diesel fuel. Following any incident the fuel tanks must be inspected for leaks and spillage. If leaks are found, they must be dealt with immediately.

CONCLUSION

Heavy equipment accidents are rare, but when they happend they present difficult situations for most rescuers. Most rescuers do not have equipment for handling such incidents. Even though all incidents are different, the incident commander must plan and follow a sequence of rescue operations.

RESCUE OPERATIONS INVOLVING ELEVATORS



INTRODUCTION

With approximately 340,000 passenger elevators in use nationwide, the chances of rescuers having to perform an elevator rescue are increasing. Nearly every commercial and industrial building with three or more stories has an elevator.

Rescuers need to know the basic operation of an elevator, and what can or cannot be done with the equipment. Rescuers need to be able to recognize the different types of emergency interlock-release keys used on the various brands of elevators, and the basic components of an elevator installation.

Preplanning allows rescuers to become familiar with elevator installations in the local area, the location of the machine room and the keys, and other information that may be of assistance during a rescue attempt. A basic knowledge of elevator equipment is not only necessary in elevator rescue procedures, it enables rescuers to cope with other elevator emergencies.

Unfortunately, this information alone cannot provide rescuers with total proficiency in rescue procedures. Rescuers must practice elevator rescue procedures under the guidance of professional elevator personnel to obtain actual experience.

ELEVATOR TYPES AND INSTALLATIONS

There are two general types of elevators: traction and hydraulic (see Figures 36 and 37).

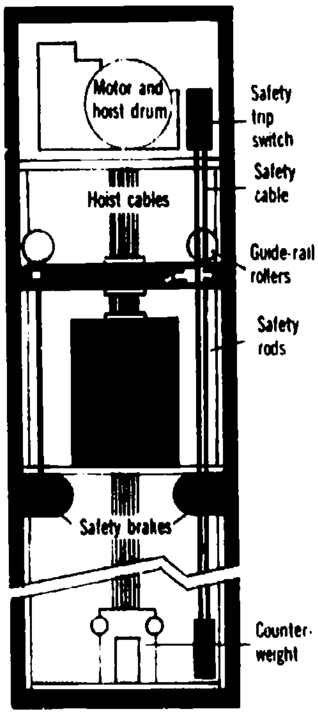


Figure 36.
Traction Elevator

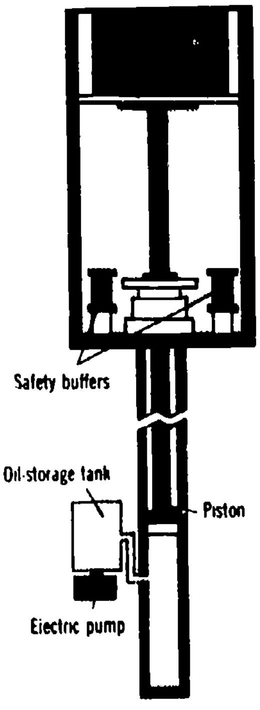


Figure 37.
Hydraulic Elevator

Traction elevators are used in high-rise buildings over 12-15 stories. They travel at speeds from 500 to 1,800 feet a minute.

Hydraulic elevators are used extensively in low-rise buildings, those up to five or six stories. Operating at speeds up to 150 feet a minute, hydraulic elevators do not need overhead hoisting machinery. Instead, the elevator is mounted on a piston inside a cylinder that extends into the ground to a depth equal to the height the elevator will rise.

Elevator installations can be divided into three general areas: (1) the machine room, (2) the hoistway, and (3) the elevator car. Each area is discussed separately to explain construction, equipment involved, and the safety features that could affect the rescue.

THE MACHINE ROOM

The equipment and machinery necessary to run and control traction elevators are located in the machine room. This includes a main electric disconnect, a traction hoisting machine, a controller, and usually a motor generator and speed governor. The machine room is usually located above the hoistway, between the elevator and the penthouse. The lighting and ventilation circuit switches for an elevator are usually located separately from the main disconnect. The car lights will remain lit and the fan or blower will continue to run even with the main circuit turned off. This provides trapped passengers more comfort while awaiting rescue.

Machine rooms with hydraulic installations have an electric motor and hydraulic pump, usually contained within one unit. The electric power in a machine room can range up to 500 volts. In case of a fire in the machine room, do not use water; apply the same precautions as with any electrical fire.

Hydraulic elevator machine rooms are usually beside the elevator pit; however, they can also be located away from the pit. In this case, the hydraulic piping is extended from a distant machine room to the elevator pit.

Machinery for a hydraulic installation is simpler and is usually compacted into one unit. The unit is made up of an oil reservoir, electric motor, hydraulic pump, and control valves. Controllers may or may not be separate. The main disconnects should be located near the entry door. There are no car safeties on hydraulic elevators, therefore, they do not have speed governors. In the past, water was used as the operating fluid in a hydraulic installation; however, in newer systems oil is used.

Hoisting Machine

Traction hoisting machines are usually installed either overhead the elevator car or in the basement of the building. Basement machines eliminate the need for rooftop penthouses or heavy hoistway construction. However, since basement installations are impractical for elevators that travel beyond 12 floors, overhead hoisting machines are found in taller buildings. A traction sheave, a driving motor, and motor brakes are found in either type of hoisting machine.

Traction Sheaves

Traction sheaves are the large grooved wheels that move the hoisting ropes (steel cable) to raise and lower traction elevators (see Figure 38).

Figure 38. Traction Sheave

Adhesive friction, called traction, enables a turning sheave to move the hoisting ropes. Round grooves are cut on a sheave, not only to guide the ropes, but also to increase the surface contact with the hoisting ropes to provide better traction. The weight of a slower elevator and their counterweights usually are sufficient to produce the necessary traction. On high-speed elevators and elevators in taller buildings, hoisting ropes pass from the traction sheave to an idler sheave and then back to the traction sheave.

Traction sheaves connect either directly or through reduction gears to the shaft of the driving motor. In the past some installations employed belt or chain drives, both of which are no longer permitted. However, a rescuer may still run into this type of installation.

Driving Motor

Driving motors are large, powerful motors powered by either alternating current or direct current (see Figure 39). The electric power can range up to 500 volts.

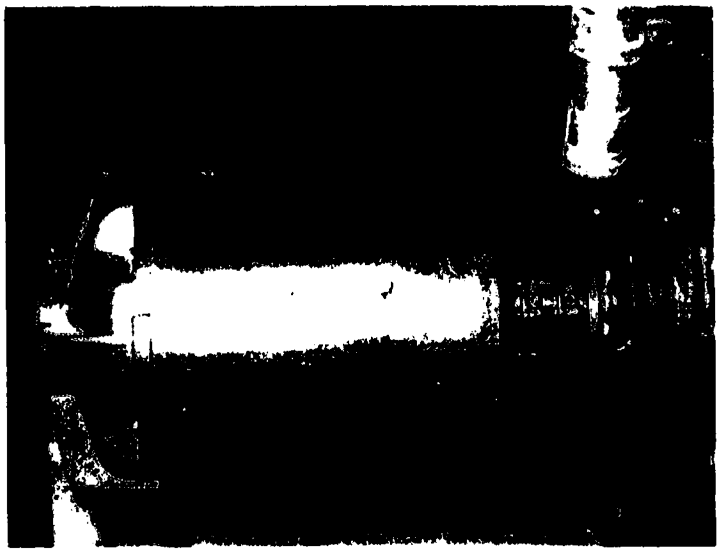


Figure 39. Driving Motor

Motor Brakes

Electric traction hoisting machines have brakes that may or may not assist in stopping an elevator. Brakes with alternating current motors are applied while the car is still in motion and aid in the stopping process. Direct current motors slow down and stop an elevator before the brake shoes actually contact the brake drum located on the motor shaft; thus brakes of this type provide no stopping action during normal operations. They hold the car and keep it from moving after the elevator comes to a rest by retarding the efforts of the direct current motor.

Motor brakes (see Figure 40) are activated by strong springs. When the electric power is removed from the brake coil, the brake coil acts as an electromagnet. As long as electricity flows to the brake coil, the coil holds the brake shoes apart. When the electric power is removed from the coil, the springs clamp the brake shoes against the drum, causing the car to immediately brake to a stop.

During an elevator rescue, the brakes can be released as a last resort to drift a stalled car to a landing. **This procedure should be performed only by an experienced elevator service mechanic, never by rescuers.**

Electrohydraulic elevators do not have brakes. The cars are brought to rest by slowing down and stopping the flow of oil either into or out of a cylinder, depending on the direction the car is moving.

Since hydraulic elevators have no brakes to hold a car when it stops, an anti-creep device is used. Cars can drift away from a landing as oil seeps out of the hydraulic system. When an elevator drifts a predetermined distance, the car contacts a switch in the shaft. The switch starts the motor, which pumps the car back up to the landing.

Figure 40. Motor Brake

Motor Generator

The alternating current in a building is converted to direct current by a motor generator. Deluxe elevator installations use direct current, and each hoisting machine has an accompanying motor generator. The motor generator has the same voltage as the driving motor, and can carry up to 500 volts.

Controller

An elevator controller is the brains behind the operation of each elevator (see Figure 41). The current inside and on top of the controller ranges up to 500 volts. Signals are received and deciphered by a controller, and the car is dispatched to the appropriate landing. An integral part of the controller is the selector. Group controllers are used when several elevators are operated together. The group controllers, called a relay controller, coordinate the actions of the cars. The relay controller receives all hall calls and dispatches the cars through the controller in a predetermined pattern.

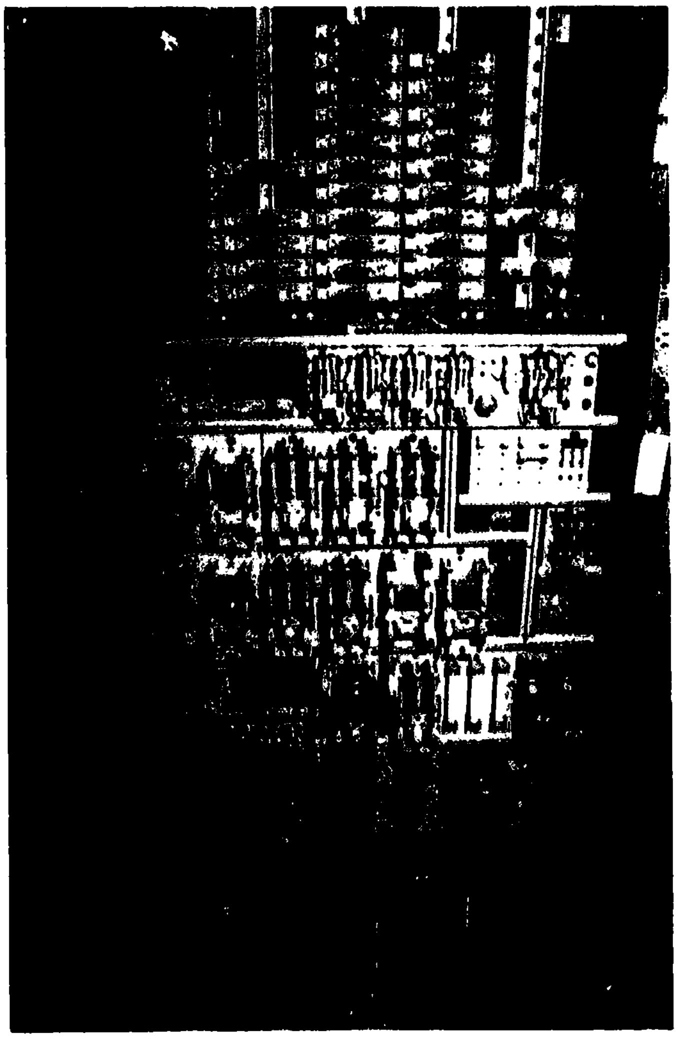


Figure 41. Elevator Controller

Selector

The selector stops, opens, closes, and starts an elevator at signaled floors. Floor bars or stops containing electric contacts are arranged up and down the selector. Floor bars are not always identified. Rescue personnel need to become familiar with the selectors in a building in which floor bars are not identified. A traveling pawl engages the contacts as it moves past the floor bars, and transmits the signals necessary for elevator operations.

Stalled elevators can sometimes be located by checking the position of the pawl in a selector.

Speed Governor

Every electric traction installation has a speed governor, which is located over the hoistway. When the machine room is located above a hoistway, the speed governor may be located in the machine room. The governor activates elevator safety equipment that prevents the car from crashing into the pit.

THE HOISTWAY

The hoistway is the vertical shaft in which an elevator travels. The elevator pit is part of the hoistway. Hoistways constructed today are enclosed with walls made of fire-resistant materials to reduce the vertical spread of fire in a building.

Vertical rails inside hoistways guide the elevator and the counterweight up and down the building. Terminal switches are fastened to the rails (or car) to ensure the slowing and stopping of an elevator as it nears the end of its travel. Beyond that, buffers located in the pit back up the terminal switches to safely arrest a runaway elevator.

Types of Hoistways

Hoistways are divided into three types: (1) single hoistways; (2) multiple hoistways; and (3) blind hoistways.

A single hoistway is a shaft found in a smaller building with only one elevator. Large office buildings may also have a single shuttle elevator used to handle freight.

Multiple hoistways are shafts that accommodate more than one elevator, with no separation between elevators within the shaft. Only four cars are permitted in one multiple hoistway.

A blind hoistway is a portion of a single or multiple hoistway without a normal landing entrance. Express elevators that serve only the upper floors of taller buildings are run through a blind shaft. An access door is usually provided in a single-blind hoistway.

Hoistway Construction

Noncombustible materials such as reinforced concrete, brick, concrete block, terra cotta, or gypsum, are used to construct hoistways. The reinforced concrete walls of a building's center core often form two or three sides of a hoistway. Fortunately, another material usually forms the landing side, since reinforced concrete walls are impossible to breach with the forcible-entry tools normally carried by rescuers. It is common to find elevator shafts constructed completely with gypsum drywall board and/or gypsum coreboard.

Hoistway Doors

A landing opening located in a hoistway is protected by doors that complete the enclosure of the shaft. An elevator hoistway maintains its fire-resistant characteristics as long as the hoistway doors remain closed during a fire.

Guiderails

T-shaped steel rails are used to guide elevators and counterweights in the hoistway. These guiderails usually fasten to the concrete hoistway walls or to the beams of steel-framed buildings. Curtain walls enclosing hoistways usually lack the strength to permit direct attachment of the rails. When walls constructed of terra cotta or gypsum, guiderails are fastened to steel beams.

SAFETY FEATURES

Terminal Switch

One of the safety devices used in elevator installations is the terminal switch (see Figure 42) located at both the top and the bottom of a hoistway. The switch operates independent of normal controlling mechanisms and causes a car to stop before reaching its upper and lower limits of travel. Once a terminal switch operates, the elevator will not run until an elevator service mechanic resets the circuit.

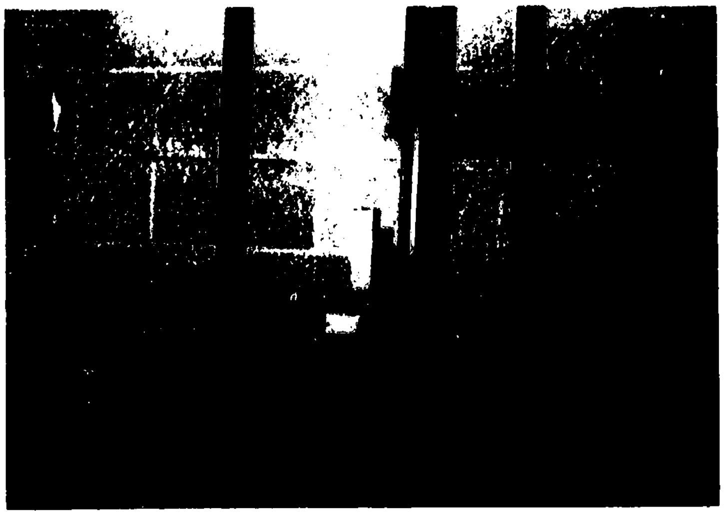


Figure 42. Terminal Switch

Buffers

Buffers, located in the elevator pit, are designed to safely halt a fully-loaded car that is running at a normal rate of speed. In the event a terminal switch fails to arrest an elevator moving past the lower landing, the car will bottom out on a buffer. Counterweights, which also have buffers, bottom out if an elevator moves past the top terminal landing.

Two types of buffers are used in modern elevator installations, spring buffers and oil buffers. The spring buffer is a large, heavy spring which is a poor absorber of energy and cannot be used successfully except with a slow-moving elevator (see Figure 43).

Figure 43. Spring Buffer

When car speeds exceed 200 feet per minute, an oil buffer is used. Oil buffers are pistons that fit into cylinders filled with oil, and absorb the impact energy of an elevator that is bottoming out. An oil buffer absorbs the impact of a car in a relatively short distance.

Car buffers are not designed to safely stop free-falling elevators but can stop a car moving slightly above its rated speed.

ELEVATOR CAR CONSTRUCTION

Elevator cars are constructed in their hoistways, making it difficult to get an overall view of a completed car. The eleva'or frame, within which sets the cab, is suspended from hoisting ropes.

Elevator Frame

The car frame is the first part of the car to be constructed with a hoistway elevator installation. It consists of a safety plank that forms the bottom of the frame, and the crosshead or the top beam, both of which are tied together by uprights. Car safeties are mounted on the frame of electric traction elevators.

Safety Planks

Safety planks support the platform (floor) of the elevator car. Safeties are attached to or built within the safety planks. The planks must be strong, since tremendous stress is imposed on a safety plank during the application of car safeties. The safety plank also absorbs the impact of a car bottoming out on a buffer.

Crosshead

Elevators are usually suspended from the hoisting ropes by the crosshead; however, hoisting ropes are attached at or below the platform of some elevator cars. The crosshead normally carries the full weight of a car.

Roller Guides

Roller guides (see Figure 44) are sets of three wheels that roll against the rails to guide an elevator up and down the hoistway. Two wheels contact the sides of the T-shaped rail and the third wheel rides the end of the rail. Roller guides mount to both the safety plank and the crosshead, one set on each side of the beam.

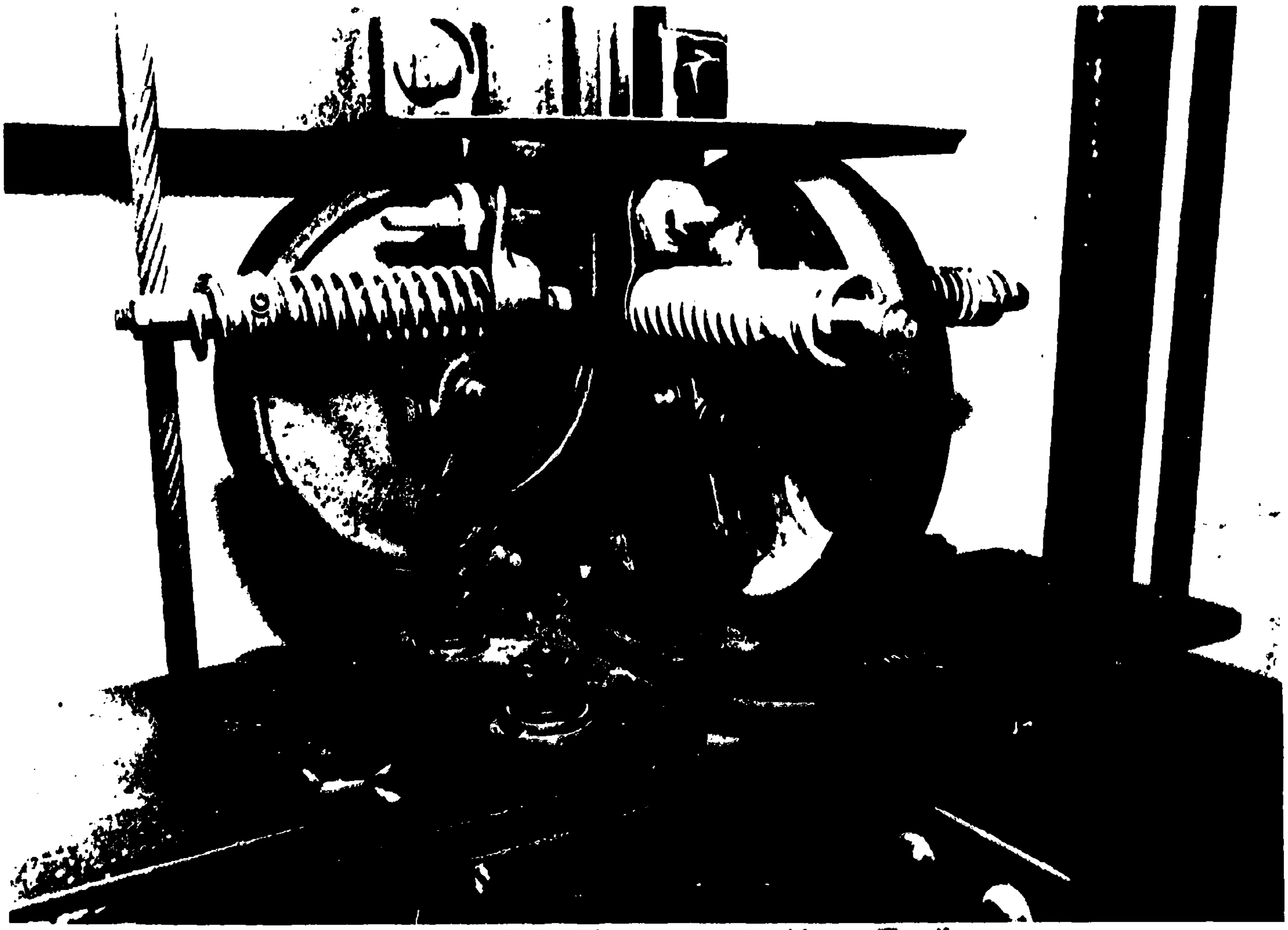


Figure 44. Roller Guides on the top of the Elevator which ride on T rails.

Hoisting Ropes (Cables)

Three-to eight-wire hoisting ropes are used to connect a car to its counterweight in a traction installation. Any one rope is strong enough to support the entire weight of a car, the passengers, and the counterweight. Although multiple hoisting cables provide a larger margin of safety against a car falling, the primary purpose of the extra cables is to increase traction.

Rope Socket

Rope sockets are used to terminate hoisting cables. The tapered socket is often part of a shackle rod. Shackle rods bolt to the crosshead and counterweight frame and are used to adjust the hoisting cables. Hoisting cables pass through the small opening of the tapered socket and the wire strands are separated, bent backwards, and pulled back into the socket. A babbitt then fills the socket to hold the wires in place. In case a fire gets into the hoistway through an open door, the babbitt can melt and the cable pull loose from the socket.

Cab Enclosures

Elevator cabs are totally enclosed by a platform, sides, a top, and doors or panels covering the required openings. An inspection station is provided on the top of most elevators.

The platform, or floor of the cab, rests on the safety plank and directly carries the passenger load. Regulations based on the size of the platform prescribe the maximum passenger load (approximately two square feet per person). However, this is not always respected and an overloaded car can shut down a system, thus trapping the passengers.

The elevator walls and top of the car are made of steel or wood. When wood is used, either sheet metal is used to cover the cab as a flame guard or the wood is treated to retard fire.

All elevator cabs have a door through which passengers enter and leave. Some elevators have two doors. Cab doors do not lock, so rescuers can easily escape a stalled elevator. Elevators ten feet in height can present a problem if rescue personnel need to exit a stalled car through the top opening.

Top Emergency Exit

Electric traction elevators have emergency exits located in the top of the car (see Figures 45 and 46). The exit panel opens outward and usually bolts or locks from the outside. Although not required, electric contacts are occasionally installed on the top exit openings, so that the car will not operate when the panel is open.

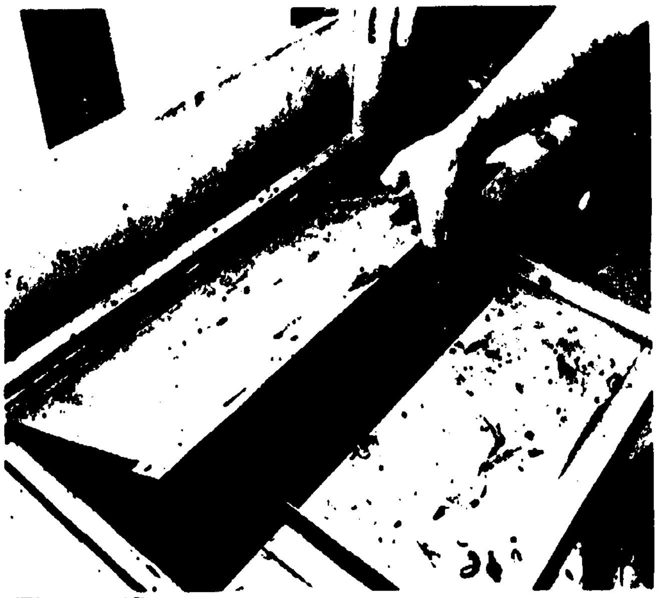


Figure 45.

Figure 46.
Two Types of Top Emergency Exists

Electro-hydraulic elevators may or may not have top exits. When an installation lacks a manually-operated valve that permits the lowering of a car in the event of power failure, the cab will have an opening. Installations with a lowering valve occasionally have the top exit; however, it is not required.

A top exit is used by rescuers to search a hoistway for fire and to escape a stalled elevator, and can be used in rescue operations. The opening can also be used as a route to the inspection station.

Side Emergency Exit Door

Elevators operating in multiple hoistways usually have side openings that line up with the side doors of adjacent cars in the hoistway (see Figure 47). Permanent handles are located on the outside panels, but a key is needed to open an exit door from inside the elevator. Sometimes a removable panel serves to cover a side opening rather than a door. Electrical contacts are required as a safety device on side emergency electric doors, so that cars cannot be moved with the door open.

Figure 47. Side Emergency Exit Door

Side exit doors are used primarily for rescue operations. Trapped passengers are transferred through the door openings from car to car. Hydraulic elevators usually do not have a side exit if there is a manually-operated lowering valve.

Inspection Station

Operating controls are installed on top of modern elevators to operate a car during inspection, maintenance, and repair. The area from which the car is operated is referred to as the inspection station. Elevators on inspection—operated from topside—travel at a limited speed, usually 150 feet or less per minute.

Inspection controls (see Figure 48) are usually mounted on the crosshead or attached to a short, flexible cord tied to the crosshead. The controls consist of several switches. One switch is used to transfer the elevator from automatic operation to inspection operation. There are direction switches used to move the car up or down. Also, there is a stop switch that removes all power from the driving motor.

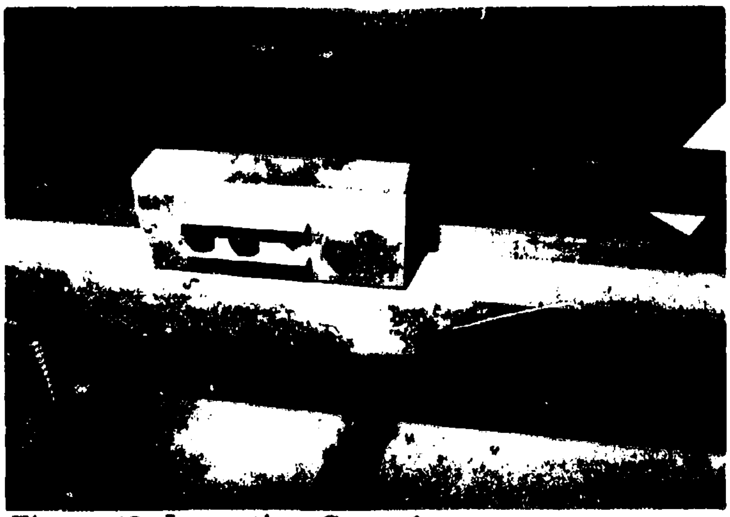


Figure 48. Inspection Controls

A safety switch has been added to some inspection controls to protect a mechanic working on top an elevator car. To activate the direction switch, the safety switch must be depressed along with the direction switch. When either switch is released the car stops. Elevators that do not have a safety switch have recessed direction buttons to avoid accidental operation of the car.

Counterweights

Counterweights on traction elevators (hydraulic cars do not have counterweights) are connected to a car by the hoisting ropes. The weight travels up and down the hoistway in its own guiderails and moves in the direction opposite to that of the car. Counterweights are usually placed at the rear of the hoistways, but are occasionally found mounted on the side in a special installation. Rescue personnel riding on top of a moving elevator must be alert to the counterweight. It is important to prevent any body part from protruding beyond the car when the elevator is in motion.

Counterweights are heavier than the car to allow for the added weight of the passengers. The complete assembly equals the weight of the car, plus 40 percent of the rated load. Smaller motors are capable of lifting a loaded elevator when the car and its counterweights are in balance.

Elevators with constantly changing loads are seldom in perfect **Balance.** Only elevator mechanics should drift a stalled car because of this imbalance factor. Depending on which component weighs the most at the time, an elevator may raise or lower when its brakes are released.

Compensating Ropes

Compensating ropes are installed to maintain a balance throughout the travel of a car and its counterweight in a hoistway. When an elevator nears a lower floor with the counterweight high in the hoistway, there is more hoisting rope on the car side of the traction sheave. The long lengths of heavy cable and the elevator car weigh more than the counterweight and the shorter amount of cable on the other side of the sheave. Conversely, when the counterweight moves near the elevator pit, the greater weight shifts away from the car side of the traction sheave and to the counterweight side. Compensating ropes make up for the seesawing imbalance, thereby permitting smaller driving motors.

Compensating ropes connect the underside of the elevator to the counterweight, passing around a guiding sheave in the pit in between the two. This sheave has a safety switch that shuts off the driving motor if a rope hangs in the sheave, or if any mishap occurs that pulls the sheave from the elevator pit.

Movement of the compensating ropes and the guiding sheave poses a threat to rescuers entering an elevator pit before the system has been shut down. **Always remove all power before entering a pit to prevent the possibility of becoming entangled in the moving equipment.** Stop switches are installed in elevator pits for this purpose.

Traveling Cables

A system must be in place within the elevator installation to convey signals from an elevator car to the controller and back to the car. A system of electrical interflow is carried by flexible cables called traveling cables. Wiring for elevator signals passes in an electric raceway from the machine room to an approximate midpoint in a hoistway. Traveling cables are attached from this midpoint to the underside of the elevator. There can be six or more cables serving each car. A cable loop travels with the car from the top to the bottom of a hoistway.

Electric power circuits for lighting and ventilation are usually attached to the building floor at the point where traveling cables connect in the hoistway. Circuit breakers for the light and fan are found on the electric panel for that floor. All other circuits for the system are controlled in the machine room.

ELEVATOR SAFETIES

Elevator safeties that prevent an elevator from ever crashing into the pit are found on most installations. The safety device is controlled by an overhead speed governor. Counterweights may occasionally have safeties; however, hydraulic elevators do not. Safeties are not required on hydraulic elevators since a car descends slowly as the hydraulic fluid is forced out of the cylinder. Buffers provide ample protection for hydraulic elevator installations.

Speed Governor

The speed governor monitors the speed of an elevator via a cable called the governor rope. The cable passes in one continuous loop from the speed governor to the operating lever for the elevator safeties, around a tension sheave into the elevator pit, and back to the speed governor. As a car moves faster, the speed governor spins more rapidly. Centrifugal force initiates several functions performed by the speed governor. At preset successive speeds, the spinning governor trips switches to slow down and stop a speeding elevator.

Speed-Reducing Governor

A speed-reducing governor acts as the name implies; it slows down the driving motor. The governor switches are tripped at the first sign that an elevator is traveling too fast. More than one speed-reducing switch may be found on the speed governor monitoring high-speed elevators. The switches pull a slowdown relay in the controller that reduces the speed of the driving motor.

Overspeed Switch

If the speed-reducing switch fails to slow down the elevator and the car gains speed, the speed governor will set the overspeed switch. This switch then cuts off power to the driving machine motor and applies the brakes.

Gripping Jaw

If the car continues to accelerate after all switches have been enacted, the governor engages a gripping jaw that seizes the governor rope. This action takes place when the uncontrolled elevator reaches a velocity of 115 percent of the rated speed of the car. Gripping jaws do not stop the governor rope entirely, but allow the cable to slow it down. Otherwise the rope might break before the safeties are completely set. If the elevator continues downward after the cable has been seized by the gripping jaw, a tensioned governor rope trips the car's safeties.

Car Safeties

A set of car safeties is located at both ends of a safety plank, one set for each guide rail. When the safeties trip, sturdy tapered safety jaws wedge against each side of a guide rail and bind the elevator, causing it to stop.

Counterweight Safeties

Counterweights must have safeties when occupied areas exist below a hoistway. For example, counterweights have safeties when elevators serve just the upper floors of a tall building and do not return to the ground floor. In such a situation, passengers must transfer to elevators serving the upper floors of the building from another elevator bank serving the lower floors. The counterweights on the upper elevator must have a safety device.

Counterweight safeties prevent a falling counterweight from crashing through the elevator pit into an occupied area. A counterweight requiring safeties has a speed governor. The operation of counterweight safeties is similar to that of car safeties.

ELEVATOR DOOR CONSTRUCTION

A rescuer's knowledge of elevator door construction and door operation may determine the success or failure of rescue procedures in many elevator emergencies. Usually, escape from a disabled elevator is through the doors. Rescuers must understand the operation and construction of elevator doors to meet the challenge presented in an elevator emergency.

The typical installation has two doors—the hoistway door and the car door. Some elevators also have an emergency exit.

Hoistway Door

Hoistway doors are attached to the shaft at each landing. These doors prevent building passengers from getting into a hoistway, and in case of fire, prevent the flames from entering the hoistway. The hoistway doors are locked and sometimes difficult to force open. Some have an unlocking device enabling them to be opened with a special key from the landing; however, most do not. To force these doors open easily with the least amount of damage, rescuers should become familiar with their basic operation.

Hoistway Door Construction.

Hoistway doors are heavy metal doors that usually have a fire-protection rating. Since the doors protect a Class B opening (an opening in a vertical enclosure in a building), they are tested like any other fire doors. In the heat of a fire, the doors will warp and become distorted, thus trapping elevator passengers. During a fire, a warped hoistway door often binds on the door jamb so that it cannot be opened wide enough for escape.

Interlock Devices

Most elevator installations have an interlock device. An interlock is an electro-mechanical device that locks the hoistway doors (see Figure 49) and

Figure 49. Interlock Device

prevents them from opening when the elevator is not at the landing. The interlock makes it more difficult for rescuers to open an elevator door for passenger rescue.

Interlocks also prevent the movement of an elevator until the hoistway doors are closed and locked. Not only must the hoistway door nearest the elevator be closed and locked, but all doors in the hoistway must be closed and locked. The locks, each of which has a set of electrical contacts, are "tied together" electrically; hence, the term **interlock**. If a hoistway door opens while the elevator is in motion, the car will brake and stop immediately. In fact, a moving car will stop as soon as the interlock releases and before the door actually opens.

Hoistway door interlocks can work against rescue personnel during fires. A major problem is that the fire and heat that invades a hoistway can short all the interlock circuits and stop all elevators. Also, water flowing into a hoistway can cause the same action.

Interlocks are usually released by a roller or a drive lock, depending on the make of the elevator. Most elevator companies use the roller, a movable wheel attached to the hoistway door. When moved, the roller releases the interlock either directly or through an extension. Drive-locks operate in the same manner.

Unlocking Devices

Certain hoistway doors can be released with a special key. Doors in single hoistways should have an unlocking device; however, this feature is not always present. In multiple hoistways, only the bottom terminal landing doors are required to have such an unlocking device. This permits access to the elevator pit when there are no access doors. In many multiple hoistway installations, the uppermost door can also be unlocked for access to the top of the elevator.

Formed Emergency (Lunar) Key

Formed emergency keys (sometimes called lunar keys by elevator mechanics) can be used to open hoistway doors that have unlocking devices. The most common keys are the semi-circular (moon-shaped) key and the drop key. An older type of key was T-shaped. Keyholes for these keys are located near the top of hoistway doors and usually take the shape of the key.

Lunar keys unlock hoistway doors in different ways. Moon-shaped keys are inserted into the opening a few inches and pulled downward. Usually, T-shaped keys trip the interlock when forced straight into an opening.

Drop keys (see Figure 50), which rotate, must be inserted far enough for the drop section to fall or swing down. Small cross pins on the keys gauge this penetration. When a cross pin stops the key, the drop section is clear of the door. Drop keys should be turned so that the drop section rotates away from the leading edge of the door.

Figure 50. Drop Key Inserted Through a Hoistway Door

Formed emergency keys are not standard in size. Diameters of the moon-shaped and drop keys usually differ. In addition, drop keys vary in length. A key of the right size must be used. This key should be available on the premises or carried on the rescue unit. Keys are often kept in a break container in or near the lower elevator in a lobby.

Hoistway door locks are designed so that they cannot be released by using ordinary tools. That is the reason for the odd-shaped lunar keys. However, it is often possible to improvise if a key cannot be located when needed. A thin screwdriver, a wire coat hanger, or an ordinary lead pencil can be used in place of moon-shaped keys. Thin wooden coffee stirrers can be substituted for T-shaped keys. If an object fits the opening and has some rigidity, it will usually work, except that it is nearly impossible to improvise a drop key.

Types of Hoistway Doors

There are four types of hoistway doors (see Figure 51) found on modern passenger elevators: (1) single-slide, (2) two-speed, (3) center-opening, and (4) swing.

It is important to understand the movement of the doors in case forcible entry becomes necessary. The location of interlocks is also important, since force should be applied as near the interlock as possible.

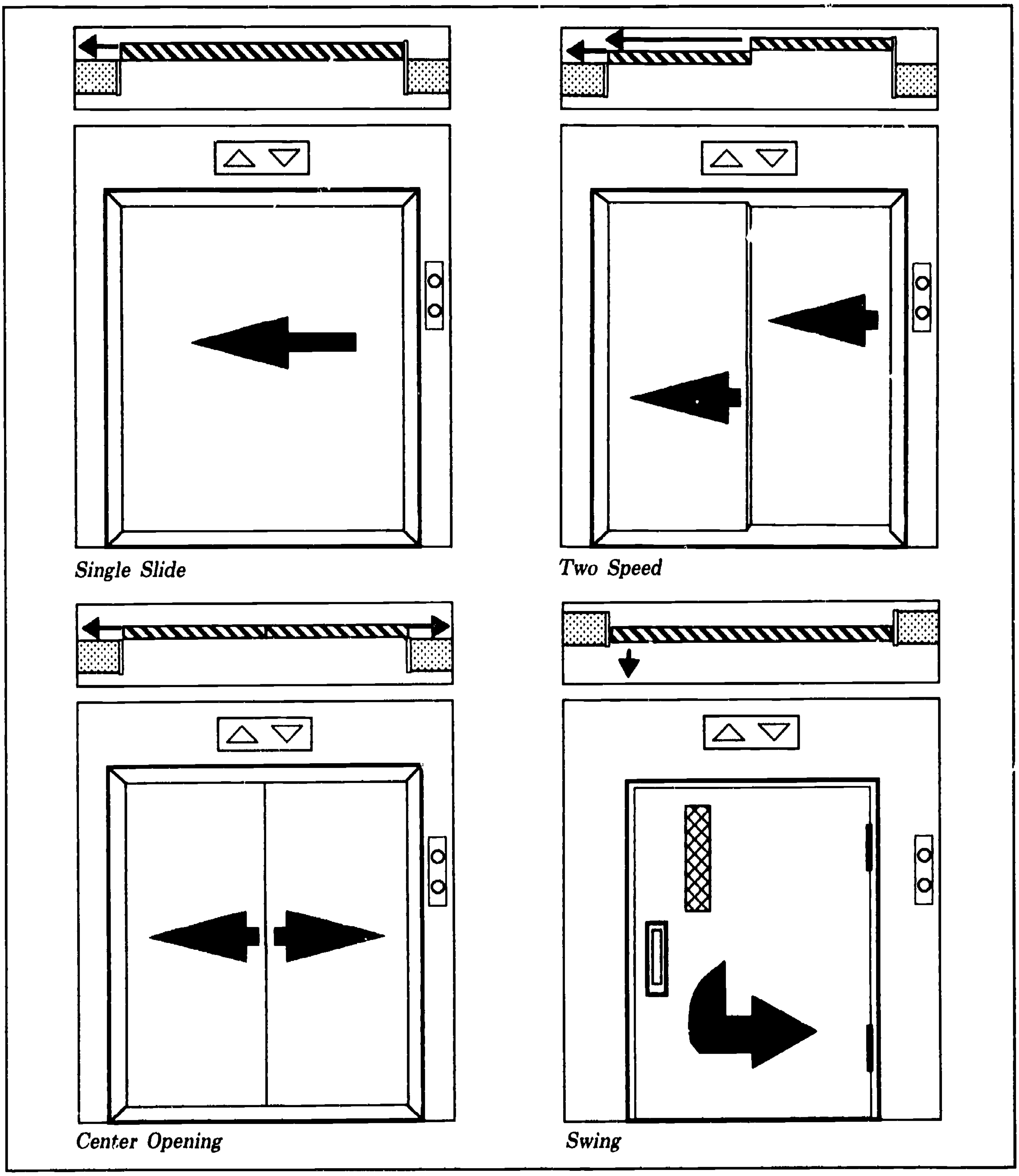


Figure 51. Types of Hoistway Doors

This information deals principally with passenger elevators; however, rescuers may have occasion to encounter the vertical bi-part doors found in a freight elevator. Freight elevators in department stores and warehouses commonly have vertical bi-part doors.

Single-slide Door. Single-slide doors are single panels that slide horizontally to one side of the door opening. They operate slowly compared to the other types of doors and are usually found in apartment buildings or small office buildings. The lock is located above the door panel on the striker jamb side.

Two-speed Door. Two-speed doors consist of two panels, one behind the other. Both panels move horizontally in the same direction, reaching the open position at the same time. The rear panel, called the "high-speed panel", contacts the door jamb when a two-speed door closes. It is that panel that has the lock. Locks will be above and to the jamb side of the high-speed panel.

Center-opening Door. Center-opening doors also have two panels but they are in the same plane. When opening, the panels move away from each other. Locks are above the point where the panels meet. Center-opening doors are used far more frequently than any other type. They are highly efficient and favored by most designers.

Swing Door. Swing doors are rarely installed in elevators for public use, but may be found in older buildings, especially small office buildings or apartments. Swing doors pivot outward from the hoistway like regular entry doors. They are not powered and must be opened and shut by hand. Swing doors have exposed butt hinges, and locks are on the handle side of a swing door, near the top.

Vertical Bi-part Door. The vertical bi-part doors of a freight elevator consist of two steel sections that move vertically. One panel moves upward while the other panel moves downward when the bi-part doors open. The panels are counterbalanced.

Locks are located to the side of vertical bi-part doors and meet where the sections meet when closed. A cam on the elevator depresses a roller to release the lock when the car levels to a landing. The lock release is usually on the side of the door opening where the hall buttons are located.

Interlocks on the lowest and uppermost bi-part doors in a hoistway can usually be released from the landing. A chain often provides for the release of a lock. Attached to the releasing roller, the chain passes through the hoistway wall and terminates in a locked container. Some locks can be unlocked by a lunar key inserted into a similar hole opening in the hoistway wall.

Car Doors

Doors attached to the elevator are called car doors and are often referred to as the gate. Car doors and hoistway doors are similar in type and construction, but car doors have no fire-protection rating. If the event of a fire, passenger safety is dependent on the fire resistance of the shaft and the hoistway doors. The elevator and its car door offer little protection for passengers once a fire enters the hoistway.

With the exception of swing doors, car doors are of the same type as hoistway doors. For example, elevators have single-sliding doors if the hoistway doors are single-slide. When the hoistway door is two-speed, the car door is a two-speed. An elevator with a swing hoistway door will have a single-slide car door or a collapsing gate.

Electric contacts. Car doors have no locks and can be opened by rescuers at any time. Protection of passengers is provided by electric contacts. Car doors must be shut before the elevator will operate. Moving elevators stop if the car doors are opened, thus preventing exposure to hoistways while cars are in motion.

Curious passengers often open the car doors of moving elevators and end up trapped. Some car doors cannot re-closed because of the operational mechanism. Elevators will not move until the doors shut and the electrical contacts are in place. This should be kept in mind by rescuers who are tempted to experiment without the guidance of an elevator mechanic. Some elevator companies have designed the doors so that they close again regardless of where the car stops after an inquisitive passenger has opened the door of the moving elevator.

Door motor. Most modern doors are power-operated. They open and close automatically when an elevator that is scheduled to stop enters a landing zone. A motor powers the car door, which drives open the hoistway door by means of contact between rollers on the hoistway door and a driving vane on the car door. Cables are involved in door operations with multipanel doors.

The motor for power-operated doors is located on top of the elevator cab. Through various methods employing belts, pulleys, and articulating levers, the motor opens and closes the car doors. The door motor powers only the car doors. Hoistway bi-part doors are powered directly; a door motor is mounted in the hoistway for each door.

Driving vane roller contact. Hoistway doors unlock when a driving vane mounted on the car door contacts and moves the roller or drive block on the hoistway door. Driving vanes are long metal bars attached vertically to the car door. When the car door is put into motion by the door motor, the driving vane strikes the roller or drive block and releases the interlock. Continuing on, the driving vane pushes open the hoistway door. Doors close by reverse action.

Contact between driving vanes and rollers occurs only when the doors are scheduled to open or close. Otherwise, the driving vane does not touch the lock-releasing roller as the elevator moves up and down past the hoistway doors. A lock is never released on a hoistway door unless the car stops at that landing.

Landing zone. Driving vanes extend beyond the roller or drive blocks both above and below, after an elevator has leveled to a landing. Depending on the length of the driving vane, an elevator can be a distance above or below the landing, and the driving vane will still contact the roller. The distance within a hoistway door that can be unlocked and opened by the moving car door is called a **landing zone**. Naturally, there is a landing zone at each floor that has a hoistway door.

In normal operations, doors begin to open when an elevator enters a landing zone. The greater the landing zone, the sooner the doors begin to open as the car slows to level off at a floor. This speeds elevator travel. High-speed elevators usually have the larger landing zones. Any time an elevator stalls within a landing zone, the hoistway doors are poised and ready to unlock with the movement of the car door.

Relating cable. When there is more than one panel to a door (i.e., two-speed and center-opening doors), the door motor moves only one panel directly. The other panel opens and closes by means of a cable attached between the two panels. The 1/8" cable, referred to as the relating cable, is roped in such a way as to control the direction and speed of the "free" panel as the door motor moves the powered panel. Hoistway doors also have relating cables, since roller cams or drive blocks mount on only one panel of the multi-panel doors. Relating cables can be served as an alternative to forcing hoistway doors.

Door-closing device. Hoistway doors are provided with a closing device that automatically shuts the hoistway door if for some reason the elevator leaves a landing with the door open. Rescuers may become trapped after entering an elevator pit through the lower hoistway door if they fail to guard against the door closing automatically.

Door clearance. Panels of hoistway doors cannot fit tightly against the entrance frame or against each other. A 3/8" clearance is required to allow doors to freely slide.

RESCUE PROCEDURES

Any elevator that stops for other than normal reasons is potentially dangerous; however, passengers are safe if they remain in the stalled car. Passenger safety is in jeopardy when an attempt is made to leave the elevator in any way other than walking out normally. In most elevator incidents, rescuers cannot bring trapped passengers out in a normal manner.

Elevator service mechanics can usually correct the failure and get the car running. If a problem cannot be fixed quickly, the mechanic can control the car manually by activating relays in the controller until the elevator moves level with a floor. In the case of complete power failure and lack of auxiliar power, the service mechanic can release the brakes on the elevator motor and drift the car to a landing. Passengers can then walk out normally. **This operation must never be attempted by rescuers.**

The best advice for rescuers when dealing with an elevator emergency is to wait for a service mechanic if possible; however, rescuers must occasionally remove trapped passengers without the guidance of an elevator expert.

Arrival at the Incident

The prelude to any rescue involves organizing the operations and locating the stalled elevator. When called to an elevator emergency, the Incident Commander should be sure a service mechanic is called and on the way. At the same time the rescuers should communicate with the trapped passengers to ensure them of their safety. One rescuer with a walkie-talkie should go to the main machine room.

Seeking Professional Help

Rescuers should always seek the assistance of professional elevator personnel. Elevator service mechanics know the equipment and can either correct the malfunction or guide rescuers in the safest rescue.

The mechanic's advice should be followed.

When an elevator emergency occurs, an elevator service mechanic is usually notified before the rescuers are dispatched. The mechanic is often the only person called unless his or her arrival is delayed; then, rescuers are called, especially if the passengers begin to panic.

Communicating With Passengers

Communication with the trapped passengers is extremely important and should take place immediately. Rescuers should let them know that an elevator mechanic is on the way, and determine if any of the passengers are ill or injured. They should be instructed to stay away from the doors and not to open the doors unless told to do so. Contact with the passengers should be maintained until they are out of the elevator.

Methods of Communication. Most elevators have an intercom system or a telephone so communication can be established with the trapped passengers. The quickest way to communicate with the passengers in a stalled elevator is via the two-way intercom. The intercom usually links the car to the main elevator lobby.

The telephone provides another means of communication on some elevators. The central elevator telephone may be located in the building manager's office, at the central switchboard, or in the central protection agency. When the telephone terminates within the building, communication with passengers presents no problem. If the telephone connects to a station not readily accessible, or the stalled elevator lacks a communication system, rescuers must locate the car and talk to the passengers from the nearest landing.

LOCATING STALLED ELEVATORS

Normally the location of a stalled elevator has been determined by the time the rescuers arrive on the scene. People are usually waiting to direct the rescuers. On occasion, however, rescuers must locate the car. There are several ways to do this.

Using the Position Indicator Panel

In most elevator installations, position indicator (PI) panels are located in both the car and the main elevator lobby. PI panels register upcoming floors as elevators move normally in the hoistway. Check the main lobby PI panel to determine the position of the car.

PI panels of high-speed elevators may be misleading. The panel may show the elevator as many as three floors beyond the location of the stalled car. A high-speed elevator stalled near the tenth floor while going up the building can be shown on the 13th floor on the PI panel. Conversely, if the car was going down when it stopped, the PI panel could show it anywhere from the tenth floor down to the seventh floor. Rescuers should call to the passengers from each of the possible landings until the car's location in the hoistway is determined.

Entering the Elevator Pit

If the indicator lights of the PI panel fail, or if the elevator installation has no PI panel, rescuers can sometimes locate the position of a stalled elevator from the elevator pit; however, precautions must be observed when entering an elevator pit.

Safety Considerations. Even though the elevator is stalled and not running, **always shut off the main power before entering an elevator pit.** Entrance to an elevator pit is gained by the pit access door through the bottom terminal hoistway door. Just inside either doorway will be a stop switch that removes electric power from the driving motor (see Figure 52). It is called the "pit stop switch" and must be activated immediately. Return the stop switch to its normal position when leaving the pit.

Figure 52. Elevator Pit Emergency Stop Switch

Prop open hoistway doors before the pit is entered, or hold the door open. Hoistway doors close and lock automatically because of the required door closer, thus making it difficult to unlock a hoistway door from inside the elevator pit. Some doors are nine feet high with the tripping mechanism located at the top of the door. Such locks are nearly impossible to reach from the pit ladder.

Spotting a Disabled Elevator. Count the hoistway doors between the pit and the stalled car to determine the elevator's location. A powerful hand light is needed to spot a car that is any distance from the pit.

The above method is limited and often inaccurate when an elevator stalls near the upper floors of a taller building. In such a case, the elevator can be spotted from the machine room. There are two areas in an overhead machine room from which an elevator stuck at the upper levels of buildings can be spotted; the smoke vent and the selector. A stalled elevator can be easily located if a vent has been installed in the machine room floor. Selectors usually are accurate in determining the position of a stalled elevator. They pinpoint the floors between which a car has stalled. Floor bars must be labeled, or the rescuers must be able to determine the relationship of the pawl to the floor bars in order to locate the elevator.

PREPARATION FOR RESUCE

Preparation for rescue is necessary for the safety of both the trapped passengers and the rescuers. Whenever an elevator stalls, there is no guarantee the car will not start again, unless rescuers ensure against its movement. The consequences of a stalled car accidentally starting are deadly. Rescue personnel can ensure against this by opening all safety circuits.

Main Disconnect

A stalled elevator can be secured against accidental movement during rescue by opening the main power circuit to the driving motor. The switch removes electric power from the driving motor and the brake coil. The main disconnects are usually located near the door of the machine room. Each switch is identified by a number corresponding to the elevator that it controls. One rescuer should throw the main switch and remain near the switch throughout the rescue to guard against accidental closing of the circuit (see Figure 53).

Figure 53. Main Disconnect

Emergency Stop Switch

Activate the car's emergency stop switch as further security against the accidental movement of the stalled elevator. This provides double insurance against the movement of the car during a rescue procedure. Most rescue authorities recommend both switches be disconnected before rescue operations begin.

Instruct trapped passengers to engage the stop button located on the operating panel of the elevator. Usually the stop button is larger or of different shape than any other button on the panel. Sometimes it is a toggle switch. The switch is always colored red. Brief operating instructions accompany most stop switches, either on the button itself or beside it. Engaging the stop switch may activate an alarm bell.

OPENING HOISTWAY DOORS

When it is necessary to remove trapped passengers from a stalled elevator, they are usually removed through the doors. Consequently, the locked hoistway door must be opened. Rescuers should follow a sequence of steps, beginning with the easiest and working to the most difficult until the doors are opened. This sequence is given below.

Opening Bound Doors

Before forcing op an elevator door in a burning building, check the door first to see if it is unlocked. Doors that bind at an elevator landing can often be opened by hand.

Attached to the bottom of the doors are gibs that guide the door panels in a groove of the door sill. Pebbles and other foreign materials transported on the shoes of the passengers often fall into this groove and bind a door in its track.

When a gib binds in its track, an opening door will stop. This can happen before the door moves open noticeably, but not necessarily before the door has moved far enough to release the hoistway door interlock. It takes very little movement of a car door to trip the interlock.

Doors that bind can generally be opened by hand. If the interlock has released before the door binds, the door can be opened from the landing by rescuers. The first act of elevator rescue is to see if the hoistway door will open. A hard rap on the door panels may dislodge whatever has caused the bind.

Opening Single Hoistway Doors

Hoistway doors of single hoistways have unlocking devices and can be opened with a lunar key. Lunar keys should be available on the premises. If not, rescue units often carry elevator keys.

Releasing the Interlock From an Adjacent Elevator

When rescue personnel do not succeed in opening the doors, it may be possible to trip the interlock from an adjacent elevator. A hand light and wooden slat or pike pole are needed to trip the interlock.

Take an adjacent elevator to the landing nearest the stalled elevator. For example, if the elevator has stalled between the sixth and seventh floors, but nearer the seventh floor, stop the adjacent (rescue) car at the seventh floor landing. To spot the interlock release on the hoistway door of the stalled elevator, focus a hand light between the car door and the hoistway door. One rescuer should reach between the doors with a pike pole and trip the interlock while another rescuer opens the hoistway door from the landing.

When releasing rollers, always move away from the leading edge of a door. If a hoistway door closes toward the rescue car, push the roller away to release the interlock. If the hoistway door closes away from the rescue car, pull the roller toward the rescue person or rescue car to trip the lock.

Pike poles are ideal for unlocking hoistway doors from adjacent elevators, because the pole's shape permits either a pull or push of the roller; however, pike poles are often too large to fit between the doors. In this case, fabricate a hook at the end of a long, wooden slat, pass it between the doors, and use it to pull the releasing roller.

Releasing the Interlock From Inside a Stalled Elevator

Interlocks cannot always be tripped from an adjacent car. The lock above a stalled elevator may be too far from an adjacent car or there may be some interfacing between cars. In such a situation rescuer must then get inside the stalled elevator to open hoistway doors.

Rescuers can gain access to stalled elevators through side emergency exit openings. Multiple hoistway elevators usually have side exits in addition to the top exit. A person can pass from car to car when elevators are level with each other.

It is difficult to align two elevators. Side exit panels have electric contacts that prevent the movement of an elevator with a side panel open. If all efforts to trip the interlock from an adjacent elevator have failed, move the rescue car to a position estimated to be even with the stalled elevator. Stop the car and open the side panel. If the elevators are not aligned evenly, reclose the side panel and move the car until the two cars align.

Occasionally, rescuers may find electric contacts that can be closed by hand, so that there is no problem aligning elevators, since the rescue car is then operable with an opened side panel. Electric contacts are released when the elevators are aligned; this stops the rescue car. It is important that the rescuer controlling the electric contacts not permit any part of the body outside the opening of the car while it is in motion.

The rescue car can also be aligned with the stalled elevator by operating from the top of the rescue car, using the controls used by elevator mechanics during an inspection. To perform this evolution, the rescue car must have an unlocking device on the hoistway door of the top floor. To gain access to the top of the car, the following steps must be followed:

- Three rescuers should take the rescue car to the top floor where one rescuer gets off with the elevator keys for the hoistway doors. The other two rescuers remain in the car and push the floor button for the floor directly under the top floor. These rescuers should be carrying the necessary tools for opening the side access door.

- When the elevator leaves the top floor, the hoistway door is opened. This stops the elevator. It should be stopped in a position so the top of the car is level with the floor. The rescuer who got off the elevator at the top floor should then reach in and flip the switch to "inspection" or "top side" run. Also engage the stop button on top of the car.
- The rescuer should now step onto the top of the car and close the hoistway doors. The emergency stop button should be released and the car run from the top by pushing either the "up" button or the "down" button.
- The rescue car will then run at a slow, controlled speed. This will make it possible to stop in line with the stopped elevator so that the rescue personnel inside the car can perform a side access rescue.
- During the rescue, the emergency "stop" buttons should be engaged and the main disconnect switches thrown to the off position in both cars.

Removable handles or keys are needed to open the side exit panels of the stalled car from inside the rescue car. These handles are attached to the side panels on the outside of the car. (Side panels are designed so that rescuers can get inside a stalled elevator, not so that trapped passengers can leave on their own.)

It is important that all safety circuits be opened before stepping across to the stalled elevator. The emergency stop switch must be activated in the rescue car. The contacts of the side exit panel will open a safety circuit. If there is communication with the rescuers in the machine room, the main disconnect of the rescue car should also be thrown to the off position.

Instruct trapped passengers to move away from the side panel because it will be opening inward. The passengers must be warned to stay where they are until a rescuer enters the stalled elevator.

The rescue person who steps into the stalled elevator, usually a distance of 30 inches or less, must make sure the stop switch has been activated correctly in the stalled car and then proceed to open the hoistway door. The rescuer may need a tool to reach the roller release to trip the lock.

After the passengers are removed from the stalled elevator, restore power to the rescue car and take the passengers to the nearest floor. To get the rescuer off the roof of the rescue car, go back to the top floor and reverse the procedure, or open another hoistway door from inside the hoistway. Be sure to return the rescue car to normal operation before closing the hoistway doors.

Forcing the Hoistway Doors

When power fails in multiple hoistways and passengers cannot trip the interlock, hoistway doors must be forced open. The use of an adjacent elevator depends on the availability of electric power. If the electrical flow to a bank of elevators has been interrupted, as in the case of a machine room fire, or a total power failure, it is impossible to run another elevator alongside a stalled car. The alternative is to force open the hoistway door above the stalled elevator.

Force must be applied as near to the interlock as possible for successful forcible entry of hoistway doors (see Figure 54). Interlocks are usually located on the header of the entrance frame in passenger elevator installations. They are positioned to one or the other end of the header on single-slide and two speed doors. Center-opening doors have locks located in the middle of the header where the door panels meet.

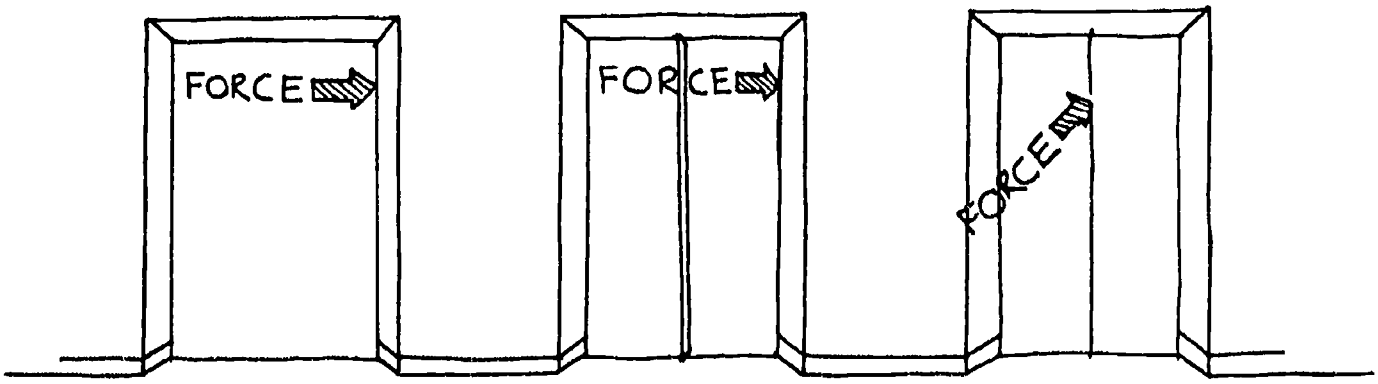


Figure 54. Apply Force Near the Interlocks

It is no problem to figure out where to apply force when opening two-speed and center-opening doors. On two-speed doors, apply force between the top of the jamb and the high-speed (rear) panel. On center-opening doors, insert a forcible-entry tool between the door panels and near the header. Force points are easily ascertained with these doors.

Single-sliding doors have no identifying features to indicate which is the lock side. Interlocks of single-sliding doors are always above the striker jamb — the jamb struck by a closing door panel. The striker jamb may or may not be beside the hall buttons. Single-sliding doors usually close toward the hall buttons. To prevent forcing a door from the wrong side and causing excessive damage, first locate the lock.

Rescuers may be able to see the stop on the striker jamb by looking between the door panel and the entrance frame. If it cannot be seen clearly, rescuers can probe for the stop with a business card, a sheet of paper, or any flat object. The striker jamb will block an object going into the hoistway, indicating on which side to force entry; the object slides into the hoistway when probed from the wrong end.

When multipanel doors (two-speed and center-opening) are forced open, either the interlock will break or the relating cable will pull loose. If the cable yields before the interlock, the panel without the lock will be freed, and can be pushed open. Rescuers can then reach behind the locked panel, trip the interlock, and move open that panel, thereby clearing the door opening completely. Air bags or hydraulic rescue tools can also be used to force open the doors.

INSTRUCTING PASSENGERS TO OPEN DOORS

Elevator Within Landing Zone

If rescuers are unable to open the doors, the next step is to have the passengers try to open them. Instruct the passengers to open the car door. Insist that the doors will open. More than minimal effort is needed to overcome the friction of moving door panels, and the drag of the dead door motor and its linkage. When a car has stalled in a landing zone, hoistway doors will unlock and move open in unison with the opening car doors.

Elevator Outside Landing Zone

Only the car door will open when the elevator is stalled outside a landing zone. Passengers must then be instructed to trip the interlock of the hoistway door. Explain the details of the release mechanism to the passengers, what it looks like, where it is located, and how it works. Rescuers should maintain slight pressure on the hoistway door while the passengers attempt to release the interlock.

Rescuers must stand ready to control the opening of the doors when the interlock is released. Do not permit the passengers to rush out.

REMOVING PASSENGERS

Through the Door Rescue

Rescue through the doors is the most common rescue, and is usually the easiest and safest option. The stalled elevator will occupy any of several positions within the door opening. Each position requires a different approach and different safety precautions.

Elevator Near Landing

When a door panel binds, or when a malfunction of the door mechanism occurs after the elevator lands, the elevator will be level, or nearly level, with the landing.

It is important that the doors not be thrown open. Rescuers must have control of hoistway doors from the time the interlock is released. Do not permit passenger to leave the car without assistance. Doors must be opened slowly to be sure all passengers are rational.

A rescuer should enter the stalled elevator immediately after the doors are opened to be sure the emergency stop switch has been activated.

Elevator Below Landing

When an elevator stalls below the landing, lower a ladder into the car to bring out the trapped passengers. Never pull passengers out by the arms; this could result in injury. One rescuer should first enter the car to make sure the emergency stop switch is activated and to foot the ladder while each person climbs out of the car. A second rescuer positioned at the top of the ladder should assist passengers onto the landing.

Elevator Above Landing

Procedures reverse when an elevator stalls above a landing. A rescuer must get into the car to be sure the emergency stop switch has been activated and to assist each passenger onto the ladder. The rescuer on the landing should foot the ladder and help the passengers climb down to the landing. The importance of having contact with passengers until each person is safely out on the landing cannot be overemphasized.

An additional hazard is present when an elevator stalls above a landing, leaving an opening in the shaft below the car. The opening must be guarded. The size of the opening will depend on the location of the car in the hoistway. The further an elevator stalls above a floor, the larger the opening. Some rescue experts advise against evacuating an elevator through the doors when the platform is farther than three feet from a landing.

Limited Door Opening

When the door opening is limited, more rescuers are needed. The extra personnel are used to guard the opening into the hoistway. Passengers cannot step onto the ladder but must lie down and slide backwards through the opening. If possible, one rescuer should enter the elevator to make sure the emergency stop switch is activated and to help the passengers slide out of the car. A second rescuer must guide passengers onto the ladder. The ladder should be secured by a third rescuer. Several rescuers should be positioned to barricade the opening under the elevator. A short ladder laid across the hoistway opening makes an ideal barrier.

When an elevator stalls too far above a landing, it may be better not to evacuate through the doors. As the size of opening through which the passengers leave the car decreases, the opening into the shaft increases; therefore, both openings become increasingly dangerous. Passengers are more susceptible to injury when passing through narrower openings.

Reconsideration of Rescue Decision

If rescuers find that trapped passengers cannot be removed safely through the doors, another method of rescue should be chosen. Some situations may not warrant the risk involved. The Incident Commander should reassess the evacuation of the stalled elevator. The number of people in the elevator, the presence of injured or ill persons, and the lighting situation in the car are all factors that influence the rescue decision.

Number of Passengers

Stalled, crowded elevators are uncomfortable, and trapped passengers become extremely uncomfortable if they have to wait any great length of time for a mechanic. If passengers are able to sit down they are usually more tolerant of a longer waiting period. Rescue may become necessary when cars are overcrowded, or if excessive delay is expected before a service mechanic arrives.

Injured or Ill Passengers

When someone is injured or becomes ill, it may be necessary to remove the person by any means available. Minor injuries do not demand immediate medical attention. Evacuating passengers from stalled elevators is hazardous; evacuating injured persons compounds that hazard.

Hysteria may require immediate attention. Rescuers must quickly calm passengers who are hysterical. Otherwise they can hurt themselves.

It is far safer to put someone into a stalled elevator to treat the injured or calm the hysterical rather than bring the passenger out by a dangerous rescue method. Emergency medical personnel can render medical care until a mechanic arrives to bring the elevator to a landing.

Elevator Lighting Situation

Elevator lights usually remain burning when the car stalls. Power for the lights is purposely provided by a circuit separate from that of the driving motor. When total power failure occurs, lights are affected. Without lights the composure of passengers can deteriorate quickly. To prevent panic and subsequent injury immediate rescue may be in order.

Top Exit Rescue

An alternate method of rescue is needed when trapped passengers cannot be moved through the hoistway or side doors and the rescue personnel decide that they cannot wait for an elevator mechanic. Top exit rescue is the alternative when an elevator stalls in a single hoistway. Top exit rescue involves three steps: (1) entering the car and removing passengers; (2) securing the passengers; and (3) removing the passenger from the hoistway.

Entering the Car and Removing Passengers

The hoistway door above the stalled elevator is used to get on top of the car. Since a top exit provides the alternative rescue method in single hoistways, the hoistway door can be opened with a lunar key. Rescue personnel should climb on top of the elevator and open the top exit panel.

Usually passenger elevators have suspended ceilings that must be removed to permit entry into the car. Remove the necessary ceiling panels carefully. Ceiling panels can be usually be slid to the side.

After the stalled elevator has been opened, a ladder should be placed in the opening and one rescuer should climb into the car. After checking to be sure the emergency stop switch has been activated, the rescuer should aid the trapped passengers in climbing up the ladder. Extend the ladder at least 3′ above the car. Elevators range up to about 10′ in height, so a 14′ ladder is sufficient.

Securing Passengers

Passengers sometimes panic once they reach the top of the elevator, and car top rescuers must guard against sudden erratic behavior. Standing on top of an elevator can be a frightening experience. Be careful no one is knocked off balance and falls between the elevator and the hoistway wall. It is recommended that rescuers tie off and attach lifelines to the passengers before they leave the elevator.

Removing Passengers from the Hoistway

Normally, three rescuers are required to bring trapped passengers through top exit openings. The rescue person in the elevator secures the passengers to a lifeline and assists each one in climbing up the ladder. Passengers are aided through the small opening above by a second rescue person on top of the elevator. The car-top rescuer helps each passenger over the crosshead to a third rescue person who helps the passenger onto the landing. Some car tops are crowded with equipment and it is difficult to move across the car. Again, rescue personnel must have a constant hold on each passenger until the passenger is positioned safely on the landing. Rescue personnel on the landing above must maintain a taut rope, taking up and releasing slack as the passengers move up the ladder and across the car.

The tops of stalled elevators will not necessarily be level with the upper landing. It may be necessary to improvise a step if the car is too far above the landing. When the top of the elevator falls below a landing, another ladder may be required. This is especially true when an elevator stalls between the first and second floors in some buildings. The stalled elevator can be situated below the second floor landing because of the height of the main lobby. In such cases, a fourth rescue person is assigned to the top to aid the passengers in climbing up the second ladder.

Side Exit Rescue

In multiple hoistways, removal of passengers through emergency side exits is the alternative to removal through the doors. Side-exit rescue is not recommended by all elevator rescue authorities. When performing any type of rescue, every precaution necessary must be taken to ensure the complete safety of trapped passengers as well as that of the rescuers.

Rescuers proceed through the steps of opening the side-exit doors of the rescue car and then of the stalled elevator until entry is gained. The rescuers are now in position to evacuate through the side exits if removal of passengers through the hoistway doors proves too dangerous or difficult.

Rescue personnel, at least one in each car, should hold onto passengers moving between elevators. Passengers should never be released by rescuers until safely inside the rescue car. A walking plank between the elevators is recommended, especially for elderly people. Ideally, the plank should measure 14″ wide and 4′ long. Securing each passenger with a safety line will add to the safety of the evacuation.

Blind Hoistway Rescue

Elevators stalled in blind hoistways present a greater challenge to rescue personnel than most other rescues. If possible, postpone the rescue until the arrival of an elevator mechanic. Rescue in blind hoistways is difficult, can be quite damaging to the building, and is often extremely hazardous.

There are multiple blind hoistways and single blind hoistways; multiple blind hoistways are more common. Each type presents unique problems in locating and evacuating stalled elevators.

Multiple-Blind Hoistway

Search and rescue can be accomplished quickly in multiple-blind hoistways as long as electric power is still available to the remaining elevators. Without power, finding a stalled elevator may take time and forcible-entry procedures may be necessary.

Power Available. When electric power is not eliminated completely in an elevator bank, rescuers can use the adjacent car to locate the stalled elevator. One rescuer should search for the stalled elevator from the top exit opening and signal another rescue person at the operating panel when the stalled car has been located and the rescue car moves alongside. The emergency stop switch will halt the rescue car. Trapped passengers are then transferred through the side-exit doors.

Side openings may also be used to search for stalled elevator in blind hoistways. When the electrical contacts of the exit panel can be closed by hand, however, this is a dangerous procedure. Rescue personnel must guard against getting beyond the opening while the elevator is in motion. The inspection station on the top of the car can also be used. This may prove to be a safe and successful operation, especially for a blind hoistway.

Power Failure. Should electric power fail in the entire elevator bank, adjacent cars cannot be used to find stalled elevators. In this situation it is impossible to accurately determine the location of the stalled elevator. PI panels do not show the various floor levels of a blind hoistway but merely indicate the car is somewhere within the blind section. If rescuers cannot decide an elevator's position by the selector, the approximate position from the elevator pit or machine room must be estimated. Counting floors in a blind hoistway is a guess since there are no hoistway doors to relate to. A floor-by-floor search should follow, beginning near the estimated level.

Searchers may be able to pinpoint a stalled car's exact position in the hoistway by sound. Instruct passengers over the intercom of the elevator to open the car door and tap the hoistway wall. The tapping can be heard by the rescuers making the floor-by-floor search. This method takes time and, hopefully, a service mechanic will arrive before the rescue actually begins.

Since adjacent elevators cannot be used for rescue, trapped passengers must be brought through the hoistway wall. This rescue will cause considerable damage. It is again wise for the person in charge of the rescue to reassess the urgency of evacuation before proceeding with the rescue. If the initial decision stands, the passengers should be instructed to close the car doors before rescue personnel breach the wall. This prevents flying fragments of debris from injuring the passengers. Evacuation after the wall has been breached should follow the same procedure as passenger evacuation through the doors. The same precautions apply.

Single Blind Hoistway

Single blind hoistways have access doors that can be used to locate and remove trapped passengers. Access doors are required at every third floor in the blind section of single hoistways.

Trapped passengers may be brought out through the top exit opening. After rescue personnel locate the stalled car, a ladder can be lowered into the car if the elevator has stalled near an access door. Otherwise, passengers must be evacuated by rope.

Access doors, like hoistway doors, have interlock circuits. An elevator will not run with an open access door. Open the main power switch and activate the emergency stop switch before the rescue.

Area Blackouts

It is possible for large areas of a city to lose electricity because of power blackouts, storms, or other major emergencies. Many elevators can become stalled simultaneously. In this instance there will not be enough service mechanics to evacuate passengers from every stalled elevator in a reasonable amount of time. Rescue personnel will have to perform rescue procedures with little hope of an elevator mechanic arriving on the scene. Despite the need for rescuers, it would be a mistake to permit rescue work by untrained persons. Trapped passengers should be left in a stalled elevator until qualified mechanics or experienced rescue personnel arrive on the scene. The passengers may become extremely uncomfortable but they will be safe.

Hydraulic Elevator Rescue

Passengers can usually be safely evacuated from hydraulic elevators. Hydraulic elevators have a manual lowering valve that is used to drift a stalled elevator to a lower landing. Passengers can then walk out normally.

Drifting a hydraulic elevator using the lowering valve is a dangerous operation. The safety circuits have no effect on hydraulic elevators being lowered manually; therefore, cars will move with their doors open. For the safety of the passengers, close the car doors before the elevator is lowered.

Passengers must be completely rational before drifting a stalled hydraulic elevator. Even though the lowering valve has a restricted orifice and cars will drift slowly, it would be dangerous to lower a stalled car unless the doors were kept closed. This is especially true when trapped passengers become hysterical. Unless rescue personnel can be reasonably assured that passengers will keep the doors shut as the car drifts, a different rescue method should be attempted.

Lowering valves are not always marked as such. Building personnel may know the location and be able to identify the valves. If the rescuers are unsure of the proper valves, do not use this method for lowering the car.

Securing the Rescue Scene

After the rescue is completed, leave the main disconnect open until the elevator is checked and serviced by an elevator mechanic. Close and lock the hoistway doors.

CONCLUSION

Rescuers should always be sure an elevator mechanic is called to an elevator emergency scene. Rescuers can evacuate trapped passengers in stalled elevators through the doors if they have a knowledge of elevator operation and elevator construction. Passengers can be safely removed when hazards of elevator rescue are recognized and precautions taken. However, there is a point after which the methods of rescue become extremely hazardous and sometimes quite damaging. Rescuers should then depend on elevator mechanics for assistance and guidance. To acquire the skills necessary to perform elevator rescue evolutions, rescue personnel must have practical experience at the site of an elevator. Arrangements should be made with an elevator company to have an elevator technician demonstrated elevator rescue operations and practice these rescue evolutions.