COLLISION COURSE:

When PITs Strike People & Objects

By GEORGE SWARTZ

In any location where powered industrial trucks (PITs) operate, one will likely find damage to the building, product and property. In addition, either operators or pedestrians (or both) have likely been injured by these vehicles. Workers or visitors may have been struck by the lift truck or indirectly injured as a result of falling product or objects struck by the PIT.

PITs are defined as mobile, power-driven vehicles used to carry, push, pull, lift, stack and tier material. They include counter-balance (sit-down) and narrow-aisle (stand-up) lift trucks, stock chasers, electric pallet trucks, elevated order pickers, low-lift platform trucks, cantilever trucks, counter-balance front/side loader trucks and single-side loader rider trucks. They can travel five to 10 miles per hour and on average weigh up to four times more than an automobile.

TABLE 1
Specific Collision Details of the Narrow-Aisle Truck Study

Collisions with racking	142 (33%)
Collisions with walls	88 (21%)
Collisions with posts	77 (18%)
Collisions with stationary objects such as tables, pallets or similar structures	69 (16%)
Collisions between forklifts	51 (12%)
Total	**427 (100%)**

TABLE 2
Collisions Producing Operator Injuries

Types of Collisions	Minor Injuries	Major Injuries	Fatalities
Between forklifts & racking	42	55	2
Between forklifts & posts	40	20	0
Between forklifts & walls	29	26	0
Between forklifts	24	29	0
Between forklifts & other objects	19	26	0
Total	**154**	**156**	**2**

STUDY CITES REARWARD TRAVEL AS A COMMON FACTOR IN MANY INCIDENTS INVOLVING NARROW-AISLE TRUCKS

- **94 percent of all collisions with racking involved traveling rearward (forks trailing).**
- **95 percent of collisions with walls involved traveling rearward.**
- **94 percent of collisions with posts involved traveling rearward.**
- **92 percent of collisions with other objects involved traveling rearward.**
- **92 percent of collisions between forklifts involved traveling rearward.**

TABLE 3
Percentage of Forklift Fatalities

Cause	Percentage
1. Tipover	25.3
2. Struck by PIT	18.8
3. Struck by falling load	14.4
4. Elevated employee on truck	12.2
5. Ran off dock or other surface	7.0
6. Improper maintenance procedures	6.1
7. Lost control of truck	4.4
8. Truck struck material	4.4
9. Employees overcome by CO or propane fuel	4.4
10. Faulty PIT	3.1
11. Unloading unchocked trailer	3.1
12. Employee fell from vehicle	3.1
13. Improper use of vehicle	2.6
14. Electrocutions	1.0

As a result, PITs can easily inflict physical damage (Schwind 20). Lift trucks can also injure, cripple or kill operators and those on foot. This article examines the nature of these collisions and outlines preventive measures designed to reduce injuries and associated costs and losses.

COLLISION-PRONE OBJECTS

PITs frequently make contact with various objects in a facility, including:

- doorways, doors, walls, posts and beams, handrailing/stairs and mezzanines;
- sprinklers and steam/gas/water pipes;
- racking and signs;
- fire extinguishers and hoses;
- electrical boxes and wiring;
- vending machines and drinking fountains;
- product on pallets or in storage, chemicals in containers;
- fencing;
- pieces of machinery and lift trucks;
- compressed gas cylinders.

In addition to these objects, PIT operators and pedestrians are also at risk. If a lift truck can strike a steel post and bend it, or strike a rack and cause it to buckle and spill thousands of pounds of product onto the floor, a person on foot does not stand much of a chance.

Table 1 presents results of a study of 804 injuries/incidents involving narrow-aisle trucks that occurred over a 19-year period (Savart). Approximately two of three injuries analyzed were the result of collisions. Collisions between forklifts, walls, racking and other objects accounted for 427 of the incident total—some 68 percent.

As the data reflect, narrow-aisle trucks typically travel in reverse (forks trailing). The significance of this data is tied to its consequences to operators. Since the operators are required to stand in a narrow compartment, their feet and legs are most vulnerable to injury. Injuries often occur when the forks or a load from another lift truck enters an operator's standing zone or other objects (e.g., product, racking) enter the standing zone while the machine is backing. Major injuries—including fractures, amputations and limb paralysis—were reported in many of these collisions. Table 2 summarizes the injuries associated with the various types of collisions.

Depending on the circumstances, some operators attempted to jump clear, dismount or stay within the standing zone. Many were injured because they had one foot outside the truck. Foot injuries accounted for 167 of the 804 incidents, while leg injuries accounted for 80 incidents. Combined, these injuries accounted for about one-third of all injuries. Some 50 percent of these injuries were major, involving fractures or amputations.

In some cases, the PIT backed under racking (known as horizontal rack intrusion), which led to employee injury. In many cases, either the lift truck's counterweight was low enough to fit under the horizontal section of storage racking bars or the floor storage area did not contain product to stop the lift truck.

Typically, injuries involved parts of the upper body—arms, back and chest. For example, in one incident at a Midwestern warehouse, the truck's counterweight entered into the racking area while it was being backed at a high rate of speed. The horizontal racking bar contacted the operator, who suffered a ruptured spleen, broken ribs, a broken arm and a back injury. He missed six months of work and injury costs were in the thousands of dollars.

Following are descriptions of other injuries associated with collisions in narrow-aisle trucks.

- A forklift struck a post while the operator's foot was outside of the lift truck. The foot was crushed and one toe was amputated.
- An operator suffered serious cuts to his hand and fingers when his PIT drove through a glass partition.
- An operator struck a wall while driving in reverse. His leg was outside the forklift and was crushed.
- An operator drove into a rack and was ejected from the PIT upon impact. He suffered injuries to the lower back and kidneys.
- While driving in reverse, an operator had his foot outside the truck's standing

TABLE 4
Collision Incidents—Automotive Studies (1989-1992)

Pedestrian Incidents	Total Incidents	Total Lost Workdays	Average Lost Workdays
Pedestrian struck by PIT	164	3,867	50
PIT struck object which struck pedestrian	34	2,796	175
Load fell or lowered on employee	33	2,218	106
Pedestrian pinned	25	947	86
Lift/position load	25	286	32
Pedestrian tripped/fell into PIT	16	169	42
Pedestrian avoiding oncoming PIT, struck object	11	98	49
Pedestrian struck by load	8	12	6
PIT ran over pedestrian's foot	6	68	17
Totals	**322**	**10,461**	**63**

TABLE 5
Circumstances of Collision Incidents (1992-1995)

Nature of Incident	Total Incidents	Percent
Pedestrian struck by PIT	86	50.3
Collision with obstruction	39	22.8
Collision with other PIT	29	17.0
PIT fell from tractor trailer	6	3.5
PIT drove over pothole	4	2.3
Passenger fell from PIT or driver jumped off	4	2.3
Rack fell onto driver	1	0.6
Load fell off rear or overloaded cart	1	0.6
Steering wheel knob broke off in employee's hand	1	0.6
Totals	**171**	**100.0**

Forklift collisions continue to present a challenge. Several studies have identified how workers are injured and product is damaged by PITs. Clearly, more must be done to train operators to safely move PITs as well as the products they are carrying. Facility management must also strive to ensure that the workplace is as hazard-free as possible.

zone. He struck a post and crushed his foot; several toes had to be amputated.

•An operator traveling at full speed struck a roof support beam. He needed 20 stitches in his forehead after being ejected from the truck.

•While driving the lift truck with raised mast, an operator struck an overhead gas line to a heater. The employee was struck in the eye by falling debris.

•A moving forklift tipped over after the raised mast struck an overhead beam. The operator jumped but was pinned by the lift truck and died.

•An operator with 20 years' experience struck a post while his foot was protruding from the forklift. His left foot was amputated.

Table 3 shows the types of incidents that OSHA has found to be involved in fatal injuries to PIT operators and pedestrians (Auguston 43). According to injury-cause descriptions, many of these cases involved collisions.

ADDITIONAL RESEARCH ON COLLISIONS

Another study examined injuries in 54 automobile manufacturing plants over a three-year period (Table 4) and identified 916 injuries associated with PITs (Collins 516). The most-common types of PIT-related injuries involved pedestrians:

•Pedestrians were struck by a PIT.

•PIT pushed, bumped or struck an object that subsequently struck a worker.

•PIT was carrying a load that was dropped or lowered onto a pedestrian.

•Employees were pinned between a moving PIT and a fixed object, rack or bin.

Many cases involved collisions with fixed objects such as poles, walls, overhead doors, racks or bins. Other incidents involved injuries to operator feet, which, in most cases, were outside the vehicle.

A second study in eight automotive manufacturing plants identified 171 PIT-involved incidents that occurred between July 1992 and March 1995 (Collins 525). Information referenced by these researchers noted that the most-frequent incidents with PITs involve workers who are struck by or run over by forklifts.

Table 5 identifies the circumstances of incidents from this study. In 86 cases (50 percent), an employee was struck by a PIT or an object being carried by a PIT or was indirectly hit by a rack, bin or other object struck by a PIT. These incidents occurred while employees were walking through the plant to exit doors, break areas, time clocks, bathrooms or the cafeteria. Thirty-nine PIT operators were injured when their vehicles struck an obstruction such as a post, rack, bin, guardrail, wall, table or fixed equipment. Twenty-nine additional injuries occured when two PITs collided. Three cases involved tipover and two cases involved a PIT that fell off a dock.

This study also included data from employee questionnaires.

Mirrors present within 50 feet of the incident site:
- Yes 10
- No 116

Obstructions at the site:
- Not Present 44
- Present 82

Floor surface:
- Incline 2
- No Incline 124

Walkways for pedestrians:
- Yes 1
- No 126

Guardrails to separate PIT traffic from pedestrians:
- Guardrails 2
- No Guardrails 124

Stop sign at site:
- Yes 15
- No 111

Aisle width:
- >12 feet 52
- <12 feet 77

Vehicle equipped with a flashing light:
- Yes 93
- No 25

TIPS FOR PREVENTION

Much can be done to prevent PIT-related damage to buildings, product and property, and avoid injury to operators

and pedestrians. Management must focus on operator training and awareness, install protective barriers, highlight hazards and improve engineering controls.

Physical Barriers

To protect offices, doorways, stairs, electrical boxes, pedestrian walkways, material storage racking, walls, steel beams, gas meters, fuel storage stations and other physical features of the facility, barriers must be installed. These can consist of heavy-walled pipe that is filled with concrete and placed deep enough into the floor to provide maximum resistance to lift truck impact. Horizontal barriers, such as those used on the highway, are also effective, particularly when painted yellow. Some organizations use black stripes on the yellow pipes to promote even greater awareness.

Highlighting posts and beams helps prevent property damage and operator injury. For example, an operator in a Midwest manufacturing plant was killed when he drove his PIT directly into a steel beam with both forks straddling the beam. The impact propelled the operator forward and he struck his head on a support post for the overhead guard.

Investigation revealed that although the area in which the PIT was operating was free of product and other machines, the operator had likely not seen the beam because it blended into the work area. Investigators concluded that had the beam been painted yellow with black stripes, the operator would have seen it in time to avoid the collision.

Metal frame barriers can be mounted on steel beams to protect electrical disconnect boxes and circuit breaker boxes. Other locations that contain electrical wiring, conduit or piping must be protected from impact as well. Barriers can be designed to fit around protected items and should protrude far enough to absorb the impact from forks, loads or pallets.

Although dangerous, forklift operators often travel with the forks and mast raised. This can lead to an incident in which the mast or forks strike an overhead beam, pipe, sprinkler line or mezzanine. If the forklift is traveling fast enough, the force of the impact could tip the truck over, which can lead to serious injuries or even death. Where possible, facility management should suspend ribbons, streamers or signage to alert operators to a low-clearance hazard.

Hazard Avoidance

Operator

- Be knowledgeable of all applicable safety rules and practices, including understanding how the truck operates and any limitations.
- Do not speed.
- Check overhead clearance before moving a load.
- Be familiar with any unusual operating conditions.

Pedestrian

- Stay back from the forklift when it is moving a load.
- If working on a ladder/platform where a forklift must pass, come down from the ladder until the forklift has passed.
- Be sure the driver can see you if you must cross the forklift's path.
- Never walk under suspended fork loads.
- Do not ride on the truck or attempt to be lifted on the forks.

Fire Safety Considerations

According to Factory Mutual Engineering & Research (FME&R), lift truck operators were the prime factors in 220 of 353 lift-truck-related losses analyzed from 1987 to 1992 ("Lift Truck" 3). Powered equipment operators were involved in two predominant causes of property damage 1) impact, which caused water damage, physical damage and structural collapse; and 2) fire.

In many of the loss cases analyzed by FME&R, forklifts caused extensive water damage when they ran, back, load-raised into or sideswiped sprinkler systems, cross mains, branch lines, risers or sprinkler heads. By their very location, in-rack sprinklers are particularly vulnerable to this type of damage.

FME&R also reported that fire incidents accounted for $146 million of some $160 million in PIT-related losses during the study period. If a truck damages piping used for processing equipment, drums or tanks, flammable liquid or other hazardous material can easily spill, and sparks from the lift truck can serve as the ignition source (Drugan 44). Such incidents are exacerbated when fire doors damaged by vehicle impact fail to close properly during an emergency.

INJURIES TO PEDESTRIANS

As noted, any employee or visitor on foot is exposed to hazards when near moving PITs or their cargo (Clark 15). Although tipover is reportedly responsible for more than 25 deaths per year, no specific data identifies all causes of PIT-related pedestrian deaths. OSHA attributes most pedestrian fatalities in the workplace to the following direct and indirect causes:

- struck by PIT;
- struck by falling loads;
- PIT struck material which then struck the pedestrian;
- faulty PIT;
- improper vehicle use.

It is difficult to quickly stop a PIT due to its weight, load, mechanical condition and braking ability. When a pedestrian and lift truck collide, the forks, wheels, counter-weight or load can cause serious injury. In many cases, a load may slide off the forks when the truck must come to an abrupt halt. In addition, the rear-end swing is short and quick, and can easily strike a pedestrian.

An article in *The Ohio Monitor* described an incident involving danger to pedestrians (Burson 23). Two employees had just stepped out of an office and into the warehouse area of a manufacturing facility when they were struck by a forklift. One woman lost her leg and the other was in a coma for three days. She later recovered, but continues to suffer from back problems. The PIT driver had only been on the job for three days. The employer had failed to train him and had not instructed him to slow down and proceed with caution near plant doorways.

In another case, an eight-ton forklift at a construction site in Chicago struck and killed a woman on her way to a dental appointment. The PIT was operating near a busy intersection and the operator was unaware that the woman was in front of him because his vision was blocked by the load being carried.

TIPS TO AVOID COLLISIONS

To maintain adequate stability, a PIT must be operated more smoothly than a

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car. Both ends of a counter-balanced truck (the counter-weight and load) swing during a turn. As noted, this rear-end swing is quick and can lead to contact with racking, product, fixed objects and pedestrians. Operators must be aware of this characteristic and factor it into their movement throughout a facility.

Most PITs do not feature shock absorbers or springs. As a result, ruts, dips, boards, debris and rough spots can cause loads to be spilled; the spilled load can subsequently strike nearby workers. To prevent such incidents, operators must be familiar with their facility and take necessary precautions to avoid such obstacles.

In addition, oil, grease, water, sand, ice or snow on the floor can hinder the vehicle's ability to stop. Operators must be alert to such conditions and must keep the truck under control at all times, maintaining at least three lengths from the truck in front.

Overloading can cause a loss of steering. Rear wheels require traction for proper vehicle control. Therefore, operators must lift only loads that the PIT can safely handle. For example, a 4,000-lb.-capacity forklift can safely lift a tilted capacity-load several inches off the floor, but such a load can cause the truck to be unstable while the load is being lifted. Therefore, loads must be reduced or higher-capacity PITs used. In all cases, pedestrians must stay clear of loads being elevated or lowered and must never walk under raised loads.

When moving throughout the facility, operators must keep loads and mast clear of overhead pipes, racking, electric cables, lights, heaters, doorways, walls, cranes, hoists and other fixed objects. They should be trained to plan for the movement of the truck and its load before proceeding. In addition, operators must avoid stacked pallets, product, racking or beams; this requires that they maintain a safe field of vision while operating the PIT.

When vision is obstructed, operators must be trained to slow down and sound the horn. PIT design does not always afford operators a clear field of vision. The mast and load limit an operator's ability to see pedestrians and other objects in their path of travel. Management should consider installing fixed mirrors to help drivers avoid pedestrians or other lift trucks.

Passing other vehicles at intersections or near blind spots can be dangerous as well. Operators should be instructed to look in the direction of travel when moving with a load or to travel in reverse if the load blocks their vision. Operators should also be trained to check blind spots frequently or to use spotters where necessary to ensure safety.

Operators must observe signs and other warnings intended to protect those on foot. PITs must only travel in lanes provided for vehicle traffic and must not endanger anyone in a walkway. In all cases, pedestrians should be warned that PITs are present. When movement begins, pedestrians should be instructed to stand back from the truck. To prevent loads from falling on anyone, operators should not raise, lower or tilt the load while traveling (Swartz 35). Remember, the higher the lifted load, the farther away the pedestrian should stand.

As noted, the stopping ability of PITs must always be considered as well. It is the operators' responsibility to ensure the safety of those working near PITs. To ensure greatest awareness, PIT operators should sound the horn and make eye contact. The horn should be sounded at a distance and continue until the operator gains pedestrian attention. Back-up alarms are another effective safeguard.

Before leaving the PIT, operators must lower the forks and load, set the parking brake and remove the key. On an incline, wheels should be chocked to prevent a runaway truck. In one documented case, a trailer truck driver was killed when struck by a runaway lift truck. OSHA fined the employer $140,000 for failing to require wheel chocking.

Management must remove any vehicle from service if a problem or defect is discovered—and keep it out of service until repairs are made. In addition, proper maintenance is essential. Documented daily inspections will help uncover problems before the vehicle is used.

OPERATOR TRAINING: A GLOBAL CONCERN

Contact between PITs and people, as well as other objects, is a universal problem. Review of injury data in Australia, Canada, Finland and the U.K. indicate that these countries face the same problem with collisions as U.S. facilities. Inadequate operator training appears to be a leading contributor to these incidents.

In Victoria, Australia, "pedestrian hit by forklift truck" accounted for 45 percent of injuries studied by researchers at Monash University (Rechnitzer 279). In Canada, the Ontario Ministry of Labor reported that between 1990 and 1995, forklifts were involved in 136 critical injuries involving 143 people and resulting in 18 worker deaths (Ontario 2). Further analysis led researchers to conclude that lack of an effective safety program was the root cause of these injuries. In Finland, of 1,500 incidents involving forklifts each year, the most-common cause of injury is PITs striking workers or fixed objects.

In the U.K., an extensive study of the wholesale distribution industry revealed that 9,592 injuries occurred between 1991 and 1997 (HSE 15). Twenty-three were fatal, 1,447 were serious injuries and 8,092 involved three or more days away from work. Three of the fatalities involved being struck by a PIT. Nine percent (119 injuries) involved being struck by a vehicle—a PIT in 74 cases. Disabling injuries (three or more days of lost time) involved 381 cases of workers being struck by a PIT.

According to the U.K.'s Health and Safety Executive (HSE), at least 8,000 PIT injuries occur each year, causing an average of 10 fatalities (H&S Commission 1). HSE attributes 30 percent of all PIT injuries to inadequate operator training. In 1999, HSE issued a special alert regarding lift truck collisions with cast iron columns following several incidents that resulted in seven roof collapses.

In the U.S., the annual toll of 85 fatalities and 35,000 serious injuries has remained fairly constant for the last 10 years (Janicak 1085). Estimates suggest that up to 25 percent of all injuries in the U.S. are caused by inadequate operator training. From July 1994 to June 1997, OSHA conducted 3,359 fatality inspections (43 percent of which were conducted in the manufacturing sector). Deaths involving PITs accounted for 3.1 percent of these inspections. In this sample, being struck by a PIT accounted for approximately 32 percent of all fatalities.

Under OSHA's new Powered Industrial Truck Operators Training Requirements (1910.179(l)(4)(iii)), employers must provide operator recertification at least once every three years. In addition, operators may need additional or corrective training when a new hazard is introduced into the workplace or when the operator is:

- assigned to a new vehicle;
- observed driving dangerously;
- involved in an accident or incident;
- unable to qualify during a skill-evaluation test.

Operators must receive specific information and training regarding the vehicle(s) they will operate in the workplace.

Operators must receive specific information regarding the vehicle(s) they will operate. Visual aids, quizzes, discussions and skills performance evaluations are mandated by the standard. In addition, the standard specifies 13 topics that must be addressed during training with regard to safe operation of PITs. Operators must also receive training in nine specified workplace-safety-related topics. Many of these training components involve safe operating procedures to prevent damage to the worksite and product, and to ensure pedestrian safety.

CONCLUSION

Forklift collisions continue to present a challenge. Several studies have identified how workers are injured and product is damaged by PITs. According to a NIOSH alert on the hazards associated with PITs, "workers who operate or work near forklifts may be struck or crushed by the machine or the load being carried."

More must be done to train operators to safely move PITs as well as the product they are carrying. Facility management must also strive to ensure that the workplace is as hazard-free as possible. Many PIT-related injuries and incidents are predictable—the statistics have not changed much over the years. With 1 million PITs being used by 1.25 million operators, more must be done to protect operators and those working nearby. ■

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