Guidelines for Retrofitting Bleachers

U.S. Consumer Product
Safety Commission
Washington, DC 20207

Pub. No. 330
000011

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Dear Colleague:

We use bleachers for viewing sporting events, graduations, parades and many other activities. Unfortunately, each year thousands of people, many of them young children, are seriously injured in falls from bleachers.

Bleachers should be as safe as possible. CPSC created these retrofitting guidelines to help identify and eliminate those features that present a fall hazard. The guidelines can be used by facility owners and operators, including school officials and parks and recreation personnel, as well as manufacturers, designers, inspectors, and regulatory officials.

They can also be used by members of the public who are concerned about bleacher safety. While some of the information in the guidelines is technical, much of it is of general interest and will be helpful to those concerned with promoting greater safety at public facilities.

Let's work together to make America's bleachers as safe as we can.

CONTENTS

APPENDIX

1. Introduction

1.1 Purpose

These guidelines provide recommendations for retrofitting bleachers to prevent falls from the bleachers. They are appropriate for use by facility owners and operators, including school officials and parks and recreation personnel, as well as manufacturers, designers, inspectors, and regulatory officials. They can be used by anyone concerned with safety while using bleachers.

These guidelines were developed by the U.S. Consumer Product Safety Commission (CPSC) in response to recommendations made at a Roundtable on Bleachers and Grandstands that was held on December 8, 1999 at CPSC. This Roundtable included consumers as well as representatives from industry and government. It was convened in response to tragedies in which two children were fatally injured and five children were severely injured due to falls from bleachers in 1998 and 1999.

The CPSC has issued these guidelines as recommendations; they are not intended as a CPSC standard or mandatory requirement. The Commission believes that, if implemented, the safety features that are recommended in these guidelines will help make bleachers safer. However, there may be other methods proposed by a professional engineer, registered architect, or qualified bleacher product and service firm that, although not presented here, may perform equally well. Also, the option of replacing bleachers as opposed to retrofitting should always be considered.

1.2 Bleacher Types

Bleachers are structures that provide tiered or stepped seating, generally without backrests, that come in various configurations and sizes. They generally fit into one of four categories: permanent/stationary, portable/movable, telescopic/folding, and temporary. Figures 1, 2, and 3 are photos of permanent, portable, and telescopic bleachers, respectively. Temporary bleachers are typically stored in pieces and are intended for use only during specific events, such as circuses, golf tournaments, and parades. These guidelines apply to all four categories of bleachers.

Figure 1: Permanent bleachers

Figure 2: Portable bleachers

Figure 3: Telescopic bleachers (open and closed positions)

1.3 Bleacher-Associated Deaths, Injuries, and Hazards

The CPSC is aware of 10 deaths that involved falls from bleachers from 1980 through 1999. Of these 10 deaths, four were children under the age of 15. Two of these occurred in 1999. In one of these cases, a 6-year-old child fell from the bleachers through a 13-inch opening between the footboard and seatboard. In the other case, a 3-year-old child fell through an opening in the guardrail.

From 1991 through 1999, there was an annual average of 19,100 bleacher-associated injuries treated in emergency rooms (ER). Data from 1999 were examined in more detail. In 1999, there were an estimated 22,100 bleacher-associated injuries treated in ERs. Approximately 6,100 of these injuries were a result of the person falling from, or through, bleachers, onto the surface below. Approximately 4,910 of these falls involved children under the age of 15.

Falls from bleachers can occur when guardrails are missing from the backs or open sides of the bleachers. Falls from bleachers can also occur when there are openings between components in the seating and guardrails that are big enough to permit a person to pass through them. These openings can exist in the following areas (and are shown in Figure 4): (1) between components of the guardrail, (2) between components of the seating, such as between the footboard and seatboard, and (3) between the bottom rail of the guardrail and the footboard or seatboard. These guidelines provide recommendations to prevent these falls.

Figure 4: Inadequate guardrails and openings that permit falls from bleachers

Bleachers can pose other potential hazards. Collapse of bleachers, particularly manually-operated telescopic bleachers, can occur if the bleachers are not operated properly. Falls on bleachers can occur when there are missing or inadequate components that assist in access and egress, such as aisles, handrails, and non-skid surfaces. These guidelines are primarily intended to address the prevention of falls from bleachers; however, some attention is also given to the prevention of falls on bleachers.

2. Prevention of Falls From Bleachers

2.1 Background

Many of the bleachers in facilities today pose a fall hazard, especially to children, in part because these bleachers may have been built and installed when the building codes did not require guardrails and allowed openings that were big enough to permit a child to fall through them. Moreover, when a jurisdiction adopts a new building code, existing bleachers are typically not required to comply because most codes do not have provisions for existing structures that would

enable the code to be applied retroactively.[1] An overview of the relevant requirements for guardrails and openings in the current codes and standards is given in the Appendix.

To prevent falls from bleachers, CPSC recommends that guardrails and openings meet the recommendations identified below. The rationale for these recommendations is also given.

2.2 Recommendations for Guardrails

Guardrails are barriers that surround elevated surfaces. To prevent falls from these surfaces, a child should not be able to pass under or through the components of a guardrail. It is also important that guardrails be designed so that they do not encourage young children to climb them.

- Guardrails should be present on the backs and portions of the open ends of bleachers where the footboard, seatboard, or aisle is 30 inches or more above the floor or ground below. See Figure 5. Bleachers with the top row nominally 30 inches above the ground may be exempt from this recommendation.
- The top surface of the guardrail should be at least 42 inches above the leading edge of the footboard, seatboard, or aisle, whichever is adjacent. When bleachers are used adjacent to a wall that is at least as high as the recommended guardrail height, the guardrail is not necessary if a 4-inch diameter sphere fails to pass between the bleachers and the wall.
- Any opening between components of the guardrail or under the guardrail should prevent passage of a 4-inch sphere.
- To discourage climbing on guardrails, guardrails should be designed in one of three ways:
  1. Use only vertical members as in-fill between the top and bottom rails.
  2. If there are openings in the in-fill that could provide a foothold for climbing, the widest measurement of the opening where the foot could rest should be limited to a maximum of 1.75 inches. Opening patterns that provide a ladder effect should be avoided.
  3. Where visibility would not be significantly impaired, use solid members.

[1] The exception to this is the National Fire Protection Association 101 Life Safety Code 2000 Edition which has provisions for existing bleachers.

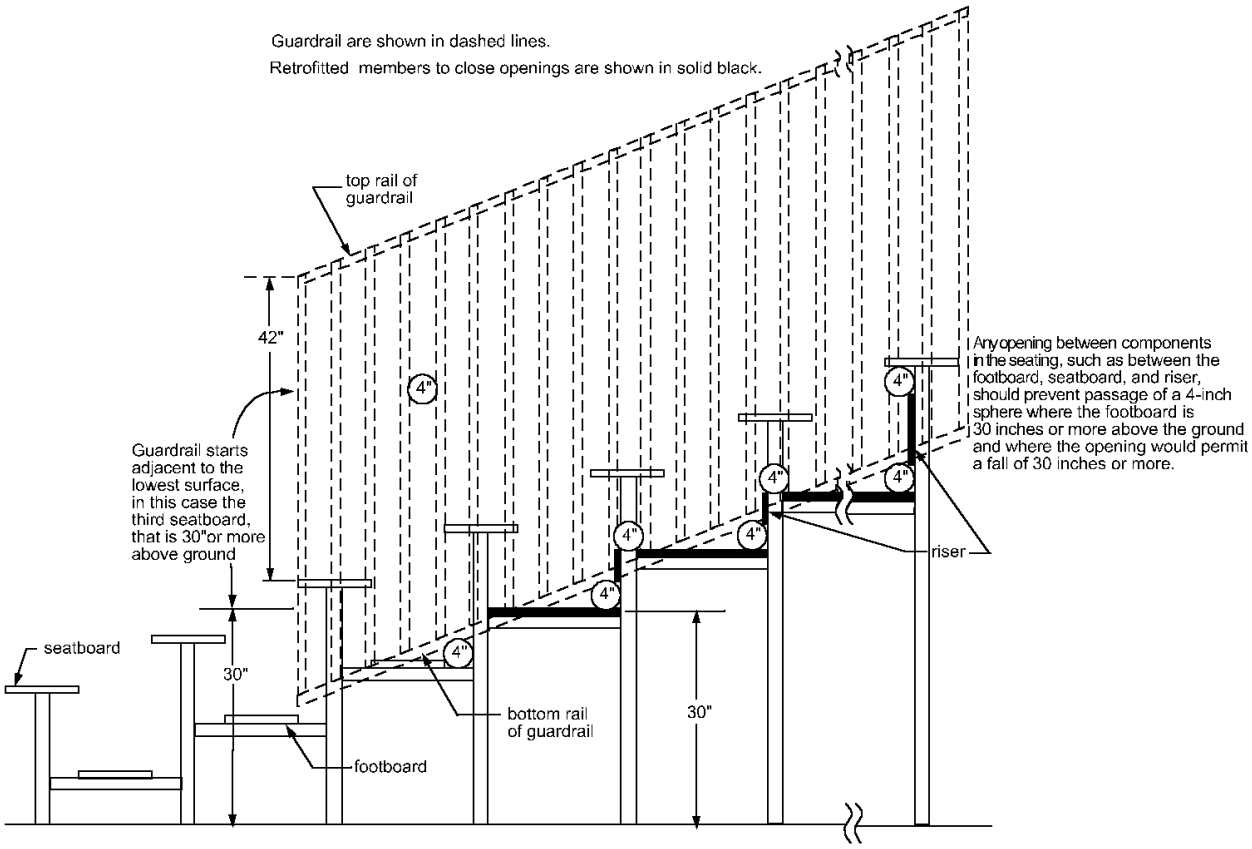

Figure 5: Recommendations for retrofitting guardrails and rigid components on bleachers where the top row exceeds a nominal 30-inch height above the ground.

2.3 Recommendations for Openings

In addition to limiting the size of openings in and under the guardrails as described above, CPSC also recommends (also see Figure 5):

- Any opening between the components in the seating, such as between the footboard, seatboard, and riser, should prevent passage of a 4-inch sphere where the footboard is 30 inches or more above the ground and where the opening would permit a fall of 30 inches or more.

2.4 Rationale for Guardrail and Opening Recommendations

The 30-inch surface height recommendation for limiting openings as well as having guardrails is based on the severity of injuries that can be sustained when a fall occurs from this height. The 42-inch rail height recommendation is intended to prevent inadvertent falls over the railings by all but the tallest 1% of adults. The 4-inch opening recommendation is based on anthropometric data showing that 95% of all children 4 months of age and older would be prevented from completely passing through a 4-inch opening. The 1.75-inch measurement for openings in guardrail in-fill is based on the foot width of a young child and is intended to reduce the potential to gain a foothold.

3.0 Prevention of Falls on Bleachers

Although these guidelines primarily focus on preventing the hazard of falls from bleachers, the prevention of falls on bleachers is important and should not be ignored when retrofitting is being considered. Falls on bleachers likely occur when there are missing or inadequate components that assist in access and egress, such as aisles, handrails, and non-skid surfaces. Many older bleachers do not have these features, yet they are important in aiding people to move safely about on bleachers. Where feasible, they should be incorporated into any retrofit project. Consult with licensed professionals or qualified bleacher firms to learn more about aisles, handrails, surfacing, and other features that should be considered to reduce the hazard of falls on bleachers. Also, consult your local building official to determine the characteristics of these features that may be in the governing building code.

4.0 General Retrofit Suggestions

4.1 Retrofit Strategies

Figures 6 and 7 depict the bleachers shown in Figure 4 after being retrofitted in order to satisfy the recommendations made for guardrails and openings. Figure 6 shows the preferable method of guardrail construction, which has only vertical components between the top and bottom rails. The vertical rails are spaced to prevent passage of a 4-inch sphere. Figure 7 shows guardrails that have been retrofitted with chain link fencing attached to the existing railings. If chain link fencing is used on guardrails, CPSC recommends only using chain link fencing which has a mesh size of 1.25-inch square or less, shown in Figure 8, so that the widest measurement of the openings measures 1.75 inches or less. This will discourage climbing by young children.

CPSC recommends use of rigid materials, such as aluminum extrusions or grating material, to close the openings between the seating components. CPSC does not recommend the use of chain link or other fencing material to close openings under the seatboards and footboards for a number of reasons. Depending on how the fencing is attached, it can introduce potential trip hazards, it can allow combustible and unsanitary debris to collect under the seats that is not easy to remove, it can be difficult to inspect for any break in integrity, and it can encourage children to play on it and hang from it.

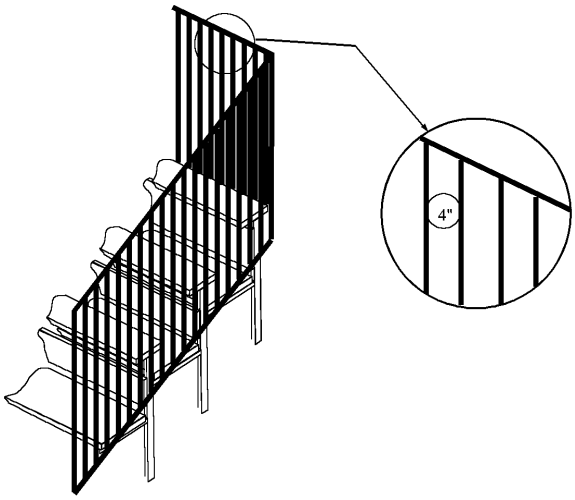

Figure 6: Vertical guardrail members spaced to prevent passage of a 4-inch sphere

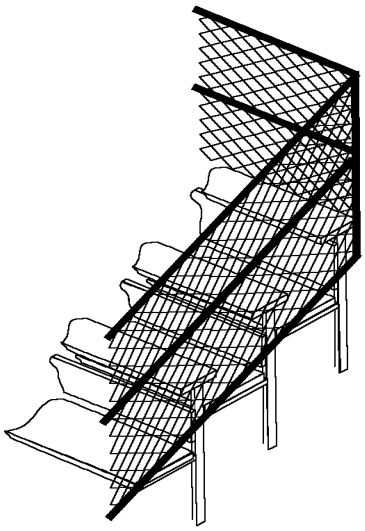

Figure 7: Guardrails with chain link fencing attached to the existing railings

Figure 8: Chain link fence with 1.25" mesh to discourage climbing by young children

4.2 Retrofit Considerations - New Hazards

Because the construction and setting of bleachers vary greatly, it is not possible to propose specific retrofit solutions that will work for all applications. The current structure and condition of the bleachers, as well as their environment, will dictate the appropriate materials and methods. Materials and methods used should prevent the introduction of new hazards. This includes possible tipover or collapse of bleachers due to improper structural loading of the retrofit hardware onto the bleachers. Depending on the weight of the additional components, combined with where and how they are attached to the bleachers, the stability of the structure could be compromised. Additional support structure or ground anchoring of the bleachers may be needed. Tipover can also result from additional wind loading on retrofitted solid members on portable and temporary bleachers that are used outdoors. In this case, semi-permanent anchors that will provide additional stability should be incorporated into the retrofit design. Poorly retrofitted guardrails that are not designed to accommodate the loading from people sitting and leaning on them can fail, creating another fall hazard. All retrofit solutions should be designed to the dead load, live load, wind load, and sway load requirements of the governing building code.

In addition to instability, retrofits should not introduce contact or tripping hazards. For example, the retrofit should not have sharp points or edges, such as protruding bolt ends or unfinished edges on aluminum extrusions.

4.3 Retrofit Planning

CPSC recommends consulting a licensed professional or qualified firm to design the best retrofit solution. A licensed professional engineer, registered architect, or company that is qualified to provide bleacher products and services, could perform this service. The option of replacing bleachers as opposed to retrofitting should also be considered. By considering the issues raised in these guidelines and working with a licensed professional or qualified company, it is possible to minimize the hazards of falls from and on bleachers. Prior to implementing any retrofit, however, the CPSC recommends consulting with the local building official to determine if a permit is required to make the alterations. Many jurisdictions require that the applicant obtain the services of a licensed design professional and submit engineering drawings before a permit will be issued.

5. Follow-Up Inspections and Maintenance

Although the frequency of inspections should depend on the amount of use, CPSC recommends that bleachers be thoroughly inspected at least quarterly to identify any structural damage or degradation that could compromise safety. All problems should be corrected immediately. Inspections and maintenance should be carried out in a systematic manner by trained personnel. Documentation of these actions, including the date and signature of the person performing them, should be retained. A licensed professional engineer, registered architect, or company that is qualified to provide bleacher products and services should inspect the bleachers at least every two years and provide a written certification at such time that the bleachers are fit for use. Records of all incidents and injuries should be retained. This will help identify potential hazards or dangerous design features that should be corrected.

Summary of Retrofit Recommendations

- Guardrails should be present on the backs and portions of the open ends of bleachers where the footboard, seatboard, or aisle is 30 inches or more above the floor or ground below. Bleachers with the top row nominally 30 inches above the ground may be exempt from this recommendation.

- The top surface of the guardrail should be at least 42 inches above the leading edge of the footboard, seatboard, or aisle, whichever is adjacent.

- When bleachers are used adjacent to a wall that is at least as high as the recommended guardrail height, the guardrail is not needed if a 4-inch diameter sphere fails to pass between the bleachers and the wall.

- Any opening between components of the guardrail or under the guardrail should prevent passage of a 4-inch sphere.

- Any opening between the components in the seating, such as between the footboard, seatboard, and riser, should prevent passage of a 4-inch diameter sphere where the footboard is 30 inches or more above the ground and where the opening would permit a fall of 30 inches or more.

- The preferable guardrail design uses only vertical members as in-fill between the top and bottom rails. If there are openings in the in-fill that could provide a foothold for climbing, the widest measurement of the opening where the foot could rest should be limited to a maximum of 1.75 inches. Opening patterns that provide a ladder effect should be avoided. If chain link fencing is used on guardrails, it should have a mesh size of 1.25-inch square or less.

- Aisles, handrails, non-skid surfaces, and other items that assist in access and egress on bleachers should be incorporated into any retrofit project where feasible.

- The option of replacing bleachers as opposed to retrofitting should be considered.

- Materials and methods used for retrofitting should prevent the introduction of new hazards, such as bleacher tipover, bleacher collapse, guardrail collapse, and contact or tripping hazards.

- Bleachers should be thoroughly inspected at least quarterly by trained personnel and problems corrected immediately. Records of these actions should be retained.

- A licensed professional engineer, registered architect, or company that is qualified to provide bleacher products and services, should inspect the bleachers at least every two years and provide a written certification at such time that the bleachers are fit for use.

- Records of all incidents and injuries should be retained.

Appendix

An Overview of Current Code and Standard Requirements
for Guardrails and Openings in Bleachers and Grandstands[2]

2000 International Building Code (IBC) of the International Code Council (ICC)

Guardrails:

- Guardrails are required on open sides which are more than 30 inches above the floor or grade below. Guards must be at least 42 inches high, measured vertically above the leading edge of the tread, adjacent walking surface, or adjacent seatboard.
- Open guards shall have balusters or ornamental patterns such that a 4-inch diameter sphere cannot pass through any opening up to a height of 34 inches. From a height of 34 inches to 42 inches above the adjacent walking surfaces, a sphere of 8 inches in diameter shall not pass.

Openings:

- Where footboards are more than 30 inches above grade, openings between the seat and footboards shall not allow the passage of a sphere greater than 4 inches.
- When projected on a horizontal plane, horizontal gaps shall not exceed 0.25 inch between footboards and seatboards. At aisles, horizontal gaps shall not exceed 0.25 inch between footboards.

1999 National Building Code (NBC) of the Building Officials and Code Administrators (BOCA)

Guardrails:

- Guards shall be located along open-sided walking surfaces which are located more than 15.5 inches above the floor or grade below. The guards shall be at least 42 inches in height measured vertically above the leading edge of the tread or adjacent walking surface.
- Open guards shall have balusters or be of solid material such that a sphere with a diameter of 4 inches cannot pass through any opening. Guards shall not have an ornamental pattern that would provide a ladder effect.

Openings:

- Openings between footboards and seatboards which are located more than 30 inches above the floor or grade below shall be provided with intermediate construction such that a sphere with a diameter of 4 inches cannot pass through the opening.
- On a horizontally projected plane, horizontal gaps between footboards and seatboards shall not exceed 0.25 inches.

[2] This summary was current as of April 2000 and is provided for informational purposes only. The reference to the codes and standards in these guidelines is not an endorsement by CPSC, in entirety or in part.

1997 Standard Building Code (SBC) of the Southern Building Code Congress International (SBCCI)

Guardrails:

- Guardrails shall be located along open-sided walking surfaces and elevated seating facilities which are located more than 30 inches above the floor or grade below. Guardrails shall be not less than 42 inches in height measured vertically above the leading edge of the tread, adjacent walking surface, or adjacent seatboards.
- Open guardrails shall have intermediate rails or ornamental pattern such that a 4-inch diameter sphere cannot pass through any opening.

Openings:

- When projected on a horizontal plane, there shall be no horizontal gaps exceeding 0.25 inch between footboards and seatboards. At aisles, there shall be no horizontal gaps exceeding 0.25 inch between footboards.

1997 Uniform Building Code (UBC) of the International Conference of Building Officials (ICBO)

Guardrails:

- Perimeter guardrails or enclosing walls or fencing shall be provided for all portions of elevated seating facilities which are more than 30 inches above grade or floor. Guardrails shall be 42 inches above the rear of a seatboard or 42 inches above the rear of the steps in an aisle when the guardrail is parallel and adjacent to the aisle.
- Open guardrails shall have intermediate rails or ornamental pattern such that a sphere 4 inches in diameter cannot pass through.

Openings:

- The open vertical space between footboards and seats shall not exceed 9 inches when footboards are more than 30 inches above grade.

2000 National Fire Protection Association (NFPA) 101 Life Safety Code

Guardrails (Applies to both new construction and existing installations):

- Guardrails are required on open sides which are more than 48 inches above adjacent ground. Guards must be at least 42 inches above the aisle or footboard or at least 36 inches above the seatboard, whichever is adjacent. The guardrail is exempted where an adjacent wall or fence affords an equivalent safeguard.
- Openings in guardrails cannot allow passage of a 4-inch diameter sphere.

Openings (Applies to both new construction and existing installations):

- Vertical openings between footboards and seatboards cannot allow passage of a 4-inch diameter sphere where footboards are more than 30 inches above grade.
- Openings in footboards cannot allow passage of a 0.5-inch diameter sphere.

Inspections (Existing installations):

- Annual inspection and maintenance of bleacher/grandstand or folding/telescopic seating required to be provided by owner to ensure safe conditions. Biennially, the inspection is to be performed by a professional engineer, registered architect, or individual certified by the manufacturer. Owner required to provide certification that such inspection has been performed as required by authority having jurisdiction.