

ENERGY ABSORPTION BARRIER COMPARISON



INTRODUCTION

OBJECTIVES

- Many tracks aren't aware that better, and potentially more affordable, barrier alternatives exist, let alone how they compare and, most importantly, how much they could increase safety standards.
- To date, a centralized source for barrier information didn't exist. Impact Safety Systems took the initiative and hired an outside firm to research and aggregate the vast, complex data available into one consolidated resource for the reference and benefit of race tracks and drivers.
- The goal was to provide as comprehensive and as unbiased an overview as possible.
- The driving purpose is to facilitate barrier safety improvements at tracks.
- Though the conclusion of this document presents the advantages of ISS Barriers, ISS acknowledges that one solution can't fit all tracks. Certain barricades, or a combination thereof, may work better for some tracks than for others.
- No matter which solution they choose, if safety upgrades are being made by tracks that were originally using concrete walls, guardrails or tires as primary barricade methods, it's a win for everyone.

METHODS

- In-depth research was conducted on behalf of Impact Safety Systems over a period of 9 months to develop a comprehensive comparison.
- Resources included manufacturer websites, literature and testing reports, as well as public domain information and published articles.
- Many claims and benefits are quoted from manufacturer's marketing, and some data was pulled from opinion editorials, thus cannot be considered objectively factual.

BARRIER SOLUTIONS COMPARED

BARRIER MANUFACTURERS

- **Impact Safety Systems** – ProLink Motorsports Barriers
- **TecPro Barriers** – High Speed Barriers
- **Scribner Plastics** – Link Barriers System
- **SAFER Barrier by MST** (Motorsports Safety Technology) - Soft Walls
- **Kart Barriers** – ISS KISS, TecPro & Scribner

OTHER BARRICADE METHODS

- **Tire Walls** – Potential Problems & Cost Analysis
- **Concrete Walls** – Potential Problems & Cost Analysis
- **Armco Guardrails** – Potential Problems

- **NOTE: AIR FENCES, FENCING AND HAY BALES NOT ANALYZED IN THIS DOCUMENT**

OVERVIEW

Impact Safety Systems *(AKA SafeLink and ProLink Barriers)*

- Established in 2000, originally founded as Kart Impact Safety Systems (KISS), then as SafeLink and later as Impact Safety Systems (ISS)
- Started in karting and evolved into motorsports
- ProLink auto racing barriers developed based on KISS barrier FEA tested technology and 15 years of real-world track testing experiences
- Designed by a pro racer for racing – RJ Valentine
- ProLink first deployed in 2011
- Race Track Customers include The Thermal Club, Inde Motorsports Ranch, The SVRA, M1 Concourse, Thompson Motor Speedway, University of Houston Law Enforcement Driver's Training Facility, Leddenham Raceway/Australia, Stadium Super Trucks, Greenwood Roadway and BMW Performance Center. Kart tracks include Homestead, MB2 Raceway, New Jersey Motorsports Park Kartplex, Pole Position, Gateway Kartplex and Little Kalamazoo Quarter Midgets
- Website: impactsafetybarriers.com



TecPro Barriers *(AKA High Speed Barriers – HSB)*

- Established in 1998
- Started in karting and graduated to car racing
- 5-6 years of R & D
- HSB co-developed by a pro driver – Rafael Galiana (in collaboration with Alpina, the FIA Institute, German automotive safety engineering group DEKRA, and lead by Hubert Gramling/German engineer and a research laboratory)
- First deployed in Formula 1 in 2006
- Race Track Customers: FIA approved for 20 international circuits and all Formula E. Kart tracks include CIK-FIA, Las Vegas SKUSA Supernationals, and the Monaco Kart Cup.
- Websites: tecpro.fr; tecprobarriers.com



Scribner Plastics *(AKA Link Barriers Systems)*

- Established in 1978
- Started in karting and car racing
- Years of R & D - No data found
- Designed by a racer for racing – Rick Scribner & Son Chris Scribner of Scribner Motorsports
- Race Track Customers: Primarily used at kart tracks nationwide, including Xstream Rock Island Grand Prix, Millennium Kart Racing and are one of the official barriers of the AKTPA
- Websites: Scribnerplastics.com; linkbarrierssystem.com



SAFER Barriers by MST *(AKA Soft Walls)*

- Established in 1999
- 5 years of R & D (In-service evaluation report dated 2004)
- Steel & Foam Energy Reduction Barrier –A joint project between Indycar and NASCAR created at their research facility, The Midwest Roadside Safety Facility (MwRSF) of the University of Nebraska-Lincoln under the direction of Dr. Dean Sicking
- First deployed in 2002 (NOTE: Conflicts with R & D Time Frame)
- Race Track Customers: Partial installations at High-speed Ovals on NASCAR & Indy Racing League (IRL) oval tracks
- Websites: racingmadesafer.com; NASCAR.com



BARRIER CONSTRUCTION

Impact Safety Systems

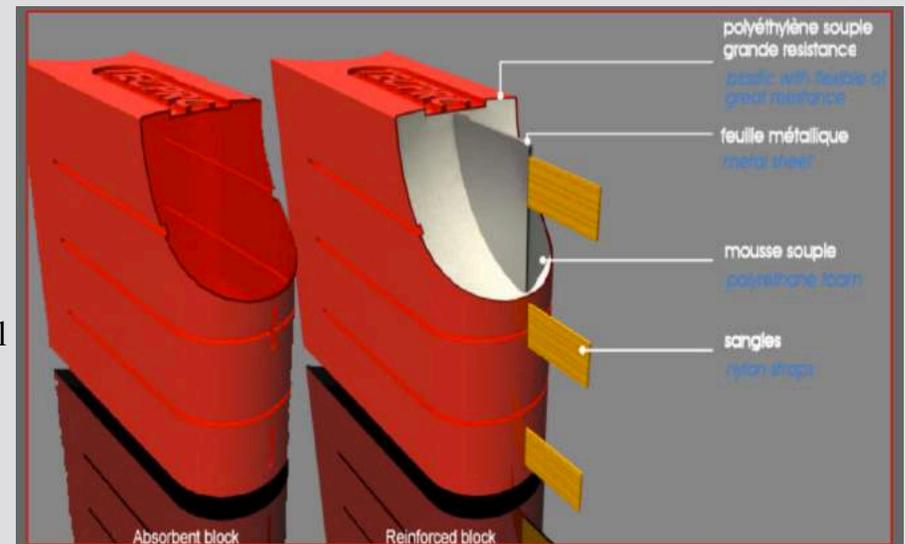
- Manufactured in the U.S.A.
- Rotationally molded from UV stabilized, weather-resistant composite Polyethylene plastic with exclusive impact ridges advanced rib wall construction
- Tongue and groove connections with unique anchoring pin system for a flush fit
- Ballast modification system when hollow barriers are filled with water or sand
- The ONLY barrier system that can be arranged in literally any configuration, including curves and 90-degree angles, or either direction of travel
- Dimensions:
79" long including knuckle
(48" pin to pin) x 24" wide (deep) x 40" high
- Thickness of Plastic: ½"
- Weight: Empty - 73 pounds / Ballasted – Approx. 500 pounds filled to 25% with water
- Specifically designed to support advertising and sponsorship banners, are available in a full range of color combinations and can be customized with graphics, embedded logos

The Thermal Club



TecPro Barriers

- Manufactured in France (and Hong Kong?)
- R1 Reinforced Blocks - Rotational molding of flexible independent polyethylene blocks connected by internal webbing
- Each block linked with three 15cm (approx. 6") nylon straps providing a flush surface with resistance up to 20T/cm²
- Tunnel shaped 2mm metal sheet/plate in center to reinforce against penetration
- Barrier filled with injected flexible polyurethane foam
- Each end is formed into a half circle enabling them to connect
- R2 Absorbent Blocks/Spacers - A second set of polyethylene blocks with empty void are interposed at set intervals behind the impact blocks to provide energy absorbing zone
- Dimensions: Both R1 and R2
150cm (59") long
120cm (47") high (alt source states 1m or 39" high)
60cm (24") wide (deep)
- Thickness of Plastic: Approx. 1/4"
- Designed and tested as part of a system with 3 separate layers:
TecPro Blocks, 4-6 rows of tire barriers and guardrail or concrete wall
Total system depth = 4m (approx. 13')
- Weight:
R1 – 110 to 120kgs (approx. 243 to 265 pounds)
R2 – 45kg (approx. 99 pounds)



Scribner Plastics

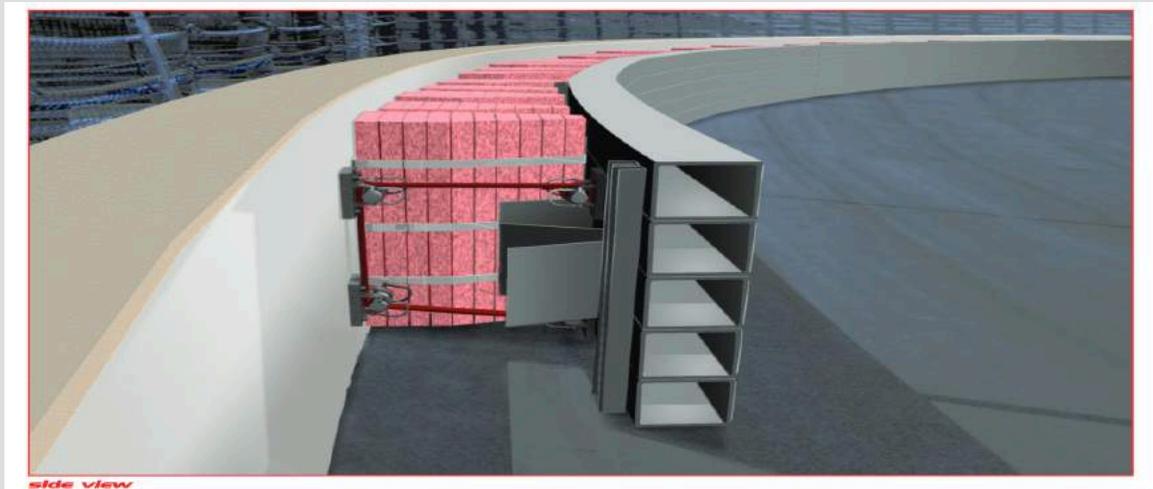
- Manufactured in America
- Rotationally molded from UV stabilized polyethylene with smooth polymer surface
- Link system with giant plastic bolt and nut
- Section joint to allow rotation to approx. 45 degrees
- Other accessories sold separately including Bull Nose Adapter to finish link end, Column Adapter for indoor tracks, Y Adapters to create islands, Double-Length Bolt to create double height wall, 6" Hatch for adding ballast, 2" 6 point Socket $\frac{3}{4}$ " Drive, Rub Rail .220" x 9" x 100' coiled (AKA Conveyor Belt) to protect barriers from being punctured by karts, Replacement Link Bolt & Nut
- Dimensions: 63" long (48" pin to pin) x 18" high x 15" wide (deep)
- Available in 3 heights – 18" (Softlink Barrier), 36" (Standard Duty), 54" (Heavy Duty)
NOTE: Unclear whether heavy duty barriers are same thickness and just stacked triple high, or thicker than kart barrier and stacked triple high
- Weight: Sources state Kart Barrier 24#
- Thickness of Plastic: Sources state $\frac{2}{15}$ " - $\frac{1}{8}$ "
- Available in many colors



Link Barrier with Link Bolt & Nut.

SAFER Barriers (Version 2 – Improved Version)

- Made in America
- Rigid tubular steel impact plate (outer skin) with vertical splice tubes to connect adjacent sections of tubular steel skin and reinforce plate
- Five 8" x 8" diameter x 3/16" thick x 28' long hollow steel tubes/pipes horizontally skip welded on top of each other to form the impact plate
- Buffered from existing wall with polystyrene (Styrofoam) trapezoidal blocks spaced on centers. Foam blocks are 2" x 22" x 40" sheets stacked and bound to create 30" x 40" pylons
- Retention devices to attach to outer wall – tethered every 20m (approx.. 66') by nylon straps to quick release, corrosion resistant galvanized alloy pins (bolts) and adjustable steel mounting plates
- Can be optimized by adjusting initial pressure
- Dimensions:
 - Impact plate sections – 8.53m (28') long X 1016mm high (40") and curved in the middle
 - Buffer blocks – 559mm (22") each



INSTALLATION/MAINTENANCE

Impact Safety Systems

- The ONLY barrier system that can be arranged in literally any configuration, including curves and 90-degree angles or either direction of travel, for maximum flexibility of use and to provide total protection for drivers everywhere on a track, or fill coverage gaps where other barricades can't
- Extremely lightweight when empty with plug and play connections and secured by a unique anchoring pin that's simple to insert or remove, ISS is the easiest system in the barrier industry to deploy
- 1000 linear feet or 250 barriers can be installed by 2 workers in only 1 day, which saves time and money
- If a barrier replacement is ever required, it takes just 1 worker less than 10 minutes to do the job, resulting in faster crash clean-up and reduced race delays
- Boston PAL Grand Prix set up a 1320' street course with 800 KISS barriers and 80 ProLink barriers using 9 workers in 3-1/2 hours
- ProLink Barriers are conveniently stackable to almost any height for efficient storage or transport, and are designed to accommodate a fork lift if needed

Impact Safety Systems at The Thermal Club



Impact Safety Systems Cont...

- Made from stronger, thicker advanced composite plastic (in some cases twice as thick as competitors), ISS Barriers are durable enough to stand up to high speed hits
- Exclusive impact ridges (ribbed side walls) increase structural integrity and make barriers less vulnerable to deformation, marking or scuffing than flat surfaces
- Fully UV-stabilized to withstand all weather conditions and proven to resist warping, bowing, cracking, breaking or shattering, thereby reducing debris and replacement costs
- Revolutionary design, ruggedized construction and exclusive impact ridges make ISS Barriers tough enough to last, substantially reducing replacement costs
- If pins are damaged during severe impact, they can be easily replaced by one corner marshal at minimal cost
- ProLink Barriers in service at University of Houston Law Enforcement Driver's Training Facility for 5 years with minimal broken barriers; Thermal Club in service for over 3 years with few broken barriers; Thompson Motor Speedway and Inde Motorsports Ranch in service for about 2 years each with a very low number of broken barriers
- No conveyor belt required
- Easily cleaned and no painting required
- Recyclable when disposed
- Unlike tires, no biohazards within barriers

Thompson Motorsports Speedway



TecPro Barriers

- Recommended Set-up Configurations:

Average speed configuration: One row of reinforced barriers (R1) is installed in front the metallic or concrete barrier and is separated by another two absorbent barriers (R2) also working as tensioners.

High speed configuration: Two row of reinforced barriers (R1) is installed and is separated by one single absorbent barrier (R2) in front of another row of reinforced barriers (R1) which in turn are separated by another two absorbent barriers-tensioners (R2) ahead of the metallic or concrete barrier

- TecPro barriers are easy and quick to install when compared to a tire system: 1000 linear meters (approx. 3281')
Tire system – 18,000 tires, 1000m conveyor belt, 36,000 bolts, 8 men, 53 working days, 40 truck movements
TecPro system – 750 R1 and 370 R2 blocks, 4 men, 15 working days, 15 truck movements of 74 barriers/truck



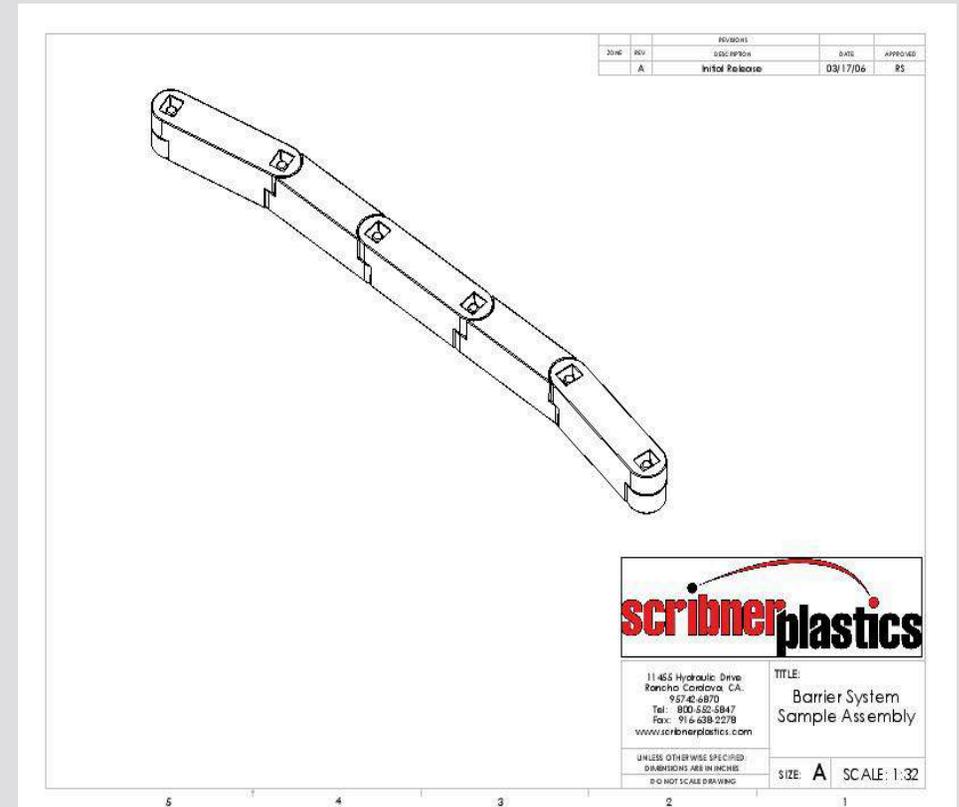
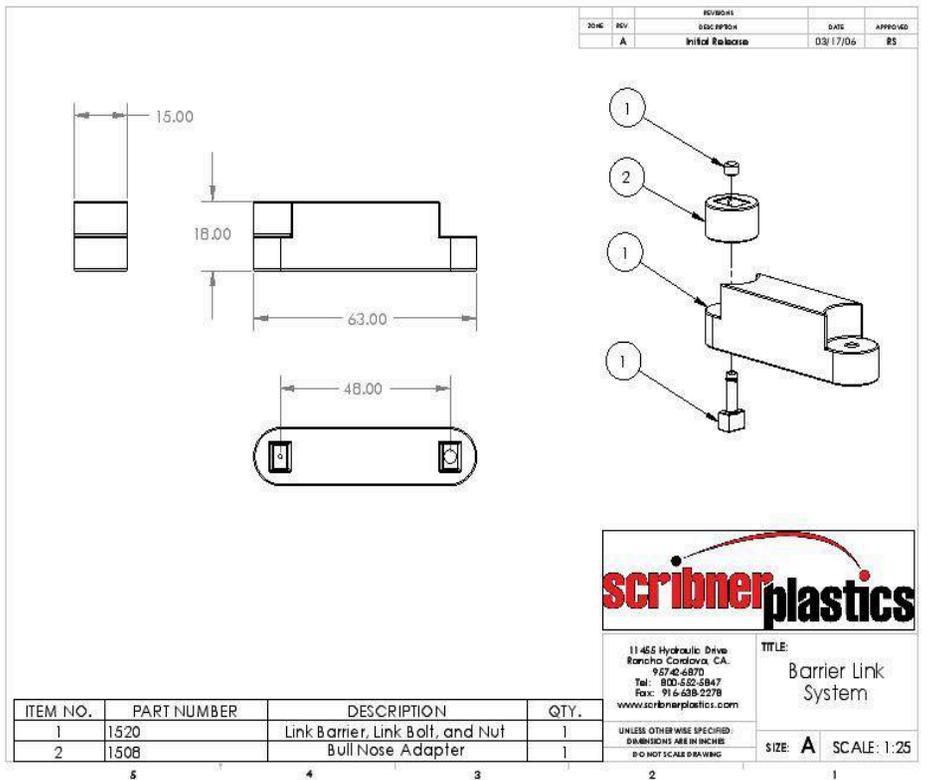
- A team of 4 technicians are required to repair TecPro barriers after a crash. In comparison, a tire system will need a team of 20
- In 8 years, one circuit replaced and recycled only 4 barriers after 4 crashes, which took 1 hour to change the barriers, versus replacing damaged tires, which averages 300 tires/year
- Adaptable to all kinds of corners and can be installed in a variety of ways

TecPro Barriers Cont....

- No conveyor belt required
- No painting required
- Easily cleaned
- No weeds or animals within barriers
- More ecological than tires as they are recyclable when disposed
- Provides easy access for track personnel and a safe place for drivers
- Easy install, replace after collision and low cost maintenance

Scribner Plastics

- Quick setup
- Flexibility for almost any layout and can be used in either direction of travel NOTE: Conflicts with rotation maximum of 45 degrees

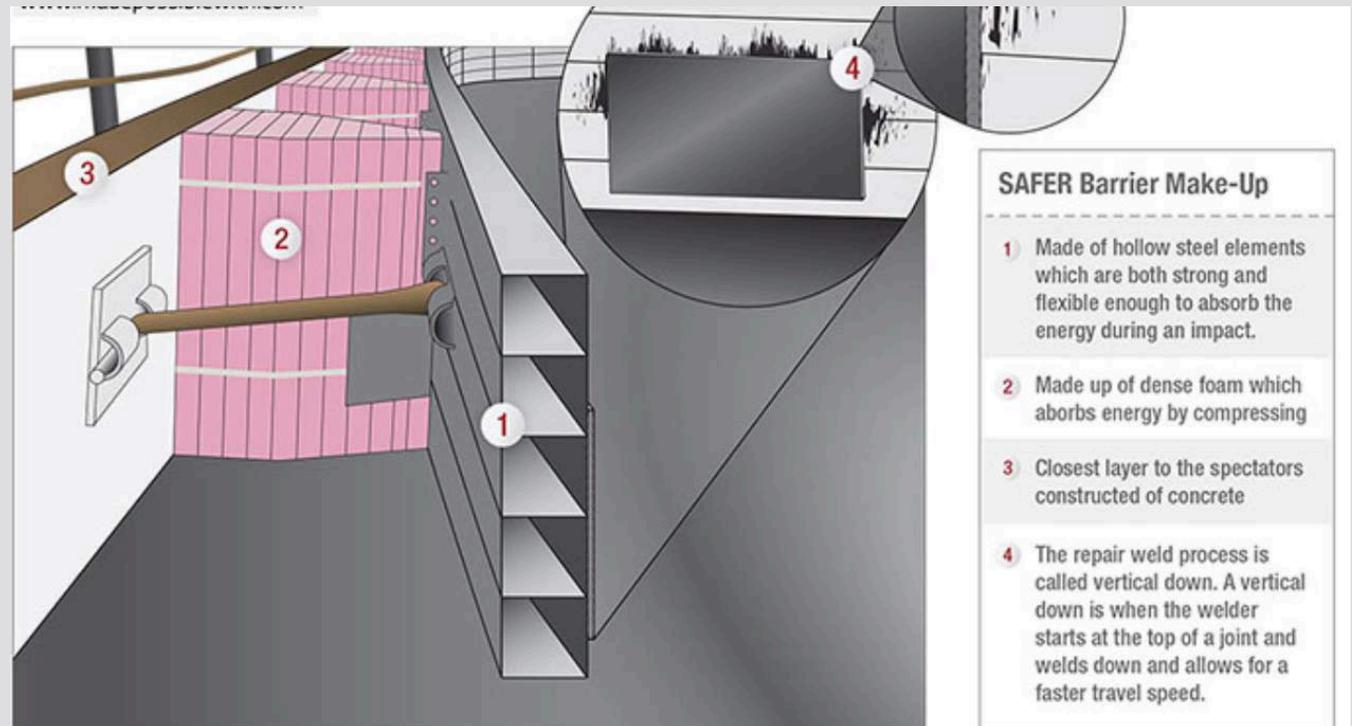


SAFER Barrier

- Starting in 2015, all steel components, including tubular steel panels and connection hardware, employ a hot-dip galvanized duplex system to prevent corrosion and extend the service life of the barriers to more than 70 years
- Foam has a proven useful life of 5 years (or longer) and MST provides a testing procedure to determine if blocks 5 years old can be used longer
- Painted barriers that begin to fail and expose the zinc surface can be repaired with minimal surface preparation as no rust will form
- Alternative backup structures made of galvanized steel have been developed to support the barriers in applications where reinforced concrete walls don't exist

SAFER Barrier

- Barriers are installed approximately 30” in front of a track’s cement walls
- Reverts to its pre-impact state rapidly
NOTE: Conflicts with Fitch statements about deformation
- Minimum race repair needs
- Shorter yellow flags
- Testing showed barrier retains its integrity in worst-case impact scenarios with little or no debris. Localized deformation and tearing of tubes on impact plate can be quickly repaired using welded patch plates



BARRIER TESTING/CLAIMS

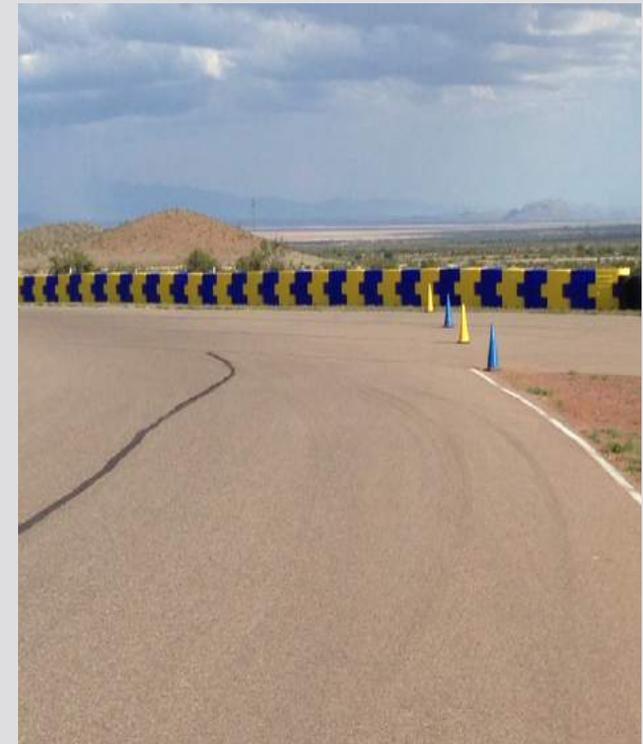
Impact Safety Systems

- ProLink auto racing barriers were developed based on the same energy absorbing FEA (Finite Element Analysis) approved technology as its smaller sized KISS Barriers for kart racing
- In developing the KISS Barriers, in-depth safety testing and collision-impact research was conducted to establish the original barrier design dynamics, determine the thickness of the polyethylene construction material, as well as the strongest surface type
- KISS Barriers surpassed FEA standards and were approved for speeds up to 80MPH with a yield of 3700 PSI range resulting in minimal deformation
- Barriers balance elasticity and durability so impact affect is absorbed by the length of the barrier and dissipated throughout with very little deformation to the wall
- Since applying this technology to the larger sized ProLink Barriers, the system's ability to dissipate impact forces has been tested and proven time and again in live scenarios at racetracks and motorcycle test tracks across America and internationally
- To date, all ISS track customers have reported high-speed hits resulting in minimal barrier deformation, very little vehicle damage and, uppermost, drivers walked away unharmed

Impact Safety Systems Cont...

- Designed to yield on impact, progressively retarding vehicle speed, absorbing energy and transferring momentum down the line of connected barriers, which cushions the shock so there's less likelihood of blunt force trauma to the driver or major damage to vehicles
- On severe impacts, the cumulative pull of the connected barriers creates a “snaking effect,” collectively causing deceleration. When buffering, ISS Barriers keep drivers from reaching a permanent hard wall
- Engineered to soften angular hits as well as frontal/head-on
- Unique linking system holds barriers in place when struck and keeps them from scattering, which minimizes hazardous debris
- Anchoring pins provide additional stabilization that reduces bounce-backs into traffic, lowering multi-vehicle collisions

Inde Motorsports Ranch



Impact Safety Systems Cont...

- ProLink is the only barrier system that offers ballast modification for varying levels of resistance. Ballast can be adjusted based on impact load, speed and weight of vehicles at different locations on a track when intermittent barriers are filled with sand or water
- Exclusive Ballast System also increases stability and makes vehicles less likely to submarine beneath the barriers
- ISS Barriers offer bright colors and directional signage options, which help raise visibility in key areas, further improving protection

The Thermal Club



Impact Safety Systems Cont...

- ISS Barriers provide more energy absorption and less bounce-back, submarining or scattering than tire walls, therefore buffering tires with a line of barriers improves safety
- One of the first plastic barrier systems designed to provide an alternative to Jersey barriers and tire walls that's easier to store, move and install, more flexible than other water-filled barriers, and protects people and vehicles better than other safety barricades on the market
- In higher impact areas or high speed turns, double or triple rows of ISS barriers as a buffer, either flush or 15 to 20' before concrete walls and/or Armco guardrails, is the optimum safety solution, even where tire walls already exist
- Thermal Club, Thompson Motor Speedway and Inde Motorsports Ranch use ProLink to buffer Armco and/or concrete walls and, when combined with pavement and gravel pit, the barriers consistently stopped cars from reaching the outer walls



TecPro Barriers

- 5 or 6-year collaborated R & D – FIA and FIM Approved & Patented
- Winner of 2006 Professional Motorsport World Expo Safety Innovation of the Year Award
- Used a combination of data from real-life accident data, computer simulation and physical tests
- 2006 series of crash tests conducted by DEKRA & FIA from 60 - 218km/h using different configurations and under different climactic conditions – Final test at 187km/h (116MPH) showed the barrier could decelerate the driver at 55G Deceleration on frontal impact (but estimate can withstand 210-220km/h (130-137MPH) impact in a limited area)
- Per TecPro data, cannot be over-ridden by F1 car tested at 218km/h (135MPH)
- Reduction of impact G force
- Barriers did not collapse or explode in a crash, or allow a vehicle to puncture the barrier, and it was possible to manually detach the crashed vehicle from the barrier (“Line of barriers does not collapse upon impact and cannot be punctured by any vehicle”)
- Per Paddock Magazine, barriers have 40% more energy absorption without boomerang effect due to tension systems inside barriers, which allows them to dissipate energy between them. Also capable of absorbing about 200km/h of impact
- Works on the principle of momentum transfer (deceleration) as opposed to energy absorption (like traditional Armco behind tires)

TecPro Barriers Cont...

- Specific research was conducted on the optimal composition of the joints between each individual element of the barrier—these must be strong enough to maintain the link in the event of a crash and allow the momentum transfer to apply, but be compliant enough to break under the shock loading event
- 6 configurations approved for all situations (based on impact speed): Average speed – 1 row R1 separated from wall by 2 rows R2; High speed – 2 rows R1 separated by 1 row R2, then separated from wall by 2 rows R2
- Maximum (gradual) absorption of energy
- “Tested more and more in GP2, GT, WTCC, WRC, F1 and FE”

Notes About Inconsistencies

- Per F1 Forensics, the FIA’s specific crash testing procedure only tested one aspect of TecPro’s barriers in 2000. Then the FIA reissued it’s certification in 2012 without updated testing.
- Per an FIA letter in 2008, TecPro barriers were approved based on 2 configurations and 2 speeds—TEC 2 (Average Speed Configuration) 85 KM/H and TEC 3 (High Speed Configuration) 135 KM/H (83 MPH), NOT 218KM/H (or 187MPH) as stated in other TecPro marketing materials.
- Per F1 Forensics and Crash.net, the FIA’s research was done based on its original intent of using TecPro as part of a multi-barrier system to safely reduce the effect of a 200KM/H collision: 2 layers of TecPro, 4 layers of tires AND 1 layer of Armco.

Scribner Plastics

- Proven track record of molding premium indoor/outdoor plastics since 1978
- DT Engineering Association performed 2 analysis simulating impact of a go-kart into the center of the Barrier Link System—Barrier with a single link and 5 links—showing the resulting movement of the systems and stress of the part upon impact in pounds per square inch (PSI). Created 4 computer simulated demo videos showing barrier assembly and stress, as well as barrier part and stress. Results showed assembly withstands impact between 2.065 and 8.880 PSI and parts withstand impact between 3.245 and 9.864 PSI
- Link barriers hollow design absorbs energy on impact
- Tightly constrained joint connectors to avoid gaps
- Surface free of ribs which can catch tires
- Can be stacked on top of each other to make them even stronger
- Double rows about 20 feet before concrete at some tracks greatly reduces the energy before hitting concrete

SAFER Barrier

- Winner of several awards including the Inaugural Pioneering Innovation Award, the SEMA Motorsports Engineering Award, the American Galvanizers Association for Excellence in Hot-Dip Galvanizing Award, and others
- 26 full-scale crash tests conducted during the development of the barrier, which were compared to real-world data
- Per Initial In-Service Performance Evaluation in 2004, live high-speed vehicle crash tests on racetracks over 3 years with varying conditions: Frontal oblique, rearward and drivers-side impacts were compared to concrete wall crash data (Real-world accidents involving SAFER barrier versus unprotected concrete)
- 30-80% crash severity reduction (based on reduction in peak deceleration and impact load) and corresponding increase in length of the crash pulse
- Research tests show reduces G force energy by over 50%

SAFER Barrier Cont...

- Uses energy absorbing technology and designed to give during impact
- Decreases driver injuries and reduces damage to vehicles during impact
- Barrier retains its integrity with little or no debris and longer repair times are not required
- Redirects the vehicle down the track without pocketing, distributes the impact load to energy absorbing foam cartridges, and extends length of crash (uses the energy of the car to deform the barriers and spread out the impact over a longer time to direct the energy away from the driver)
- Eliminates dangerous slingshot effect seen by other flexible wall solutions
- Prevention of car being caught and spun or flipped
- Foam blocks are formatted to the correct density and allows for variable compression amounts depending on weight and speed of racecar
- More effective than tires for more common impacts like 45-degree angle

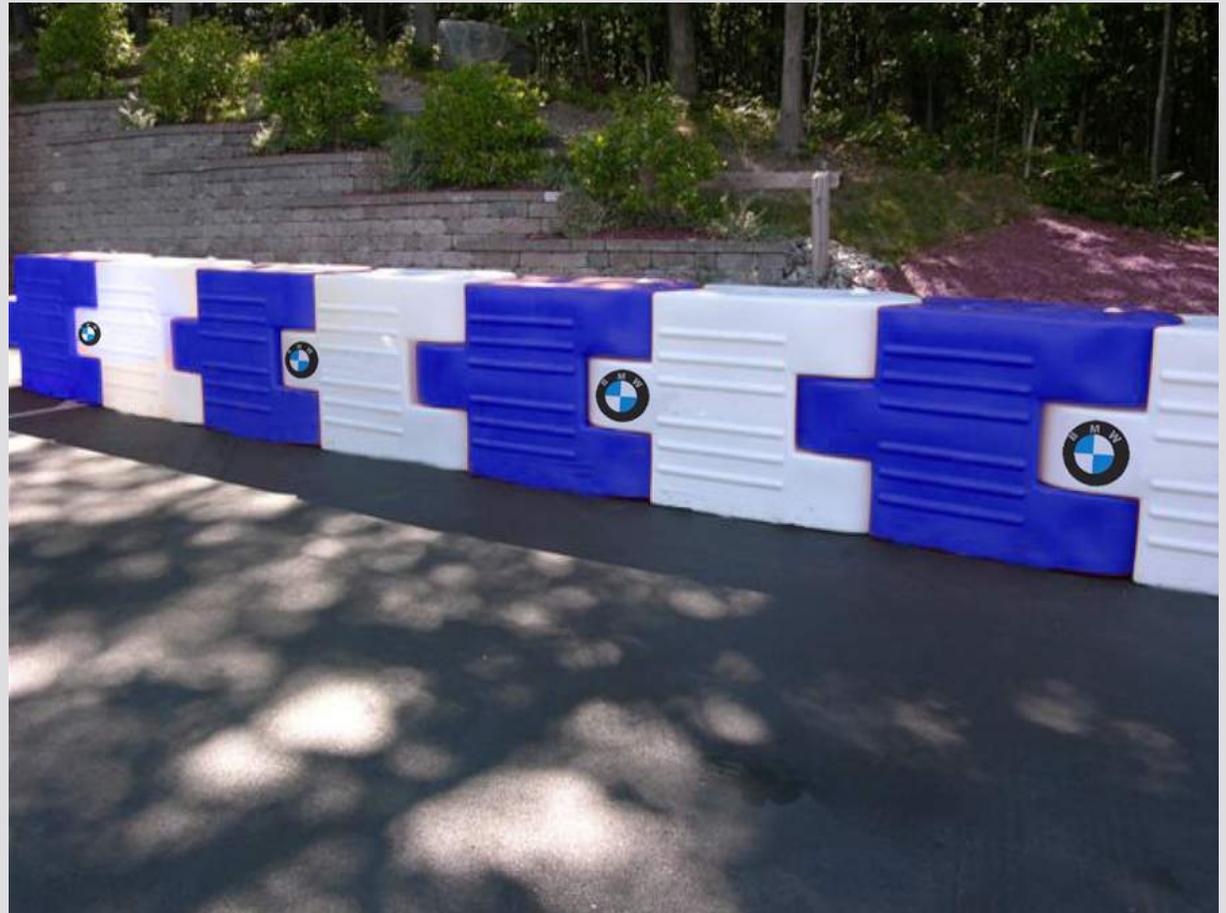
SAFER Barrier Cont...

- With frontal impact, any energy dissipated will help the driver survive without, or lessen, head or internal injuries
- As of July 2014, based on historical data, Sicking estimates SAFER walls have helped save some 8 driver's lives
- Website has testimonials from 7 racers: Dario Franchitti, Danica Patrick, Scott Dixon, Ryan Newman Ryan Hunter-Reay, Ryan Briscoe and Jeff Gordon (plus other testimonials in the press)
- Suitable for both open and closed wheel racecars
- Racers have been calling for SAFER barriers everywhere, around the entire circumference of all tracks. To date, Iowa Speedway is the only one completely surrounded

OTHER BENEFITS/CLAIMS

Impact Safety Systems

- ISS is a portable, flexible barrier solution designed for road courses, short tracks and ovals
- Ideal for temporary tracks as well as permanent
- Tracks appear cleaner, more up-to-date and attractive on camera
- Barriers can be customized with embedded logos and in colors to coordinate with branding



Impact Safety Systems Cont...

- ISS Barriers can accommodate advertising banners, which generates additional income
- ISS Barriers also support signage for directions, instructions or warnings
- The flexibility and portability of ISS Barriers make them adaptable to a wide range of applications— auto race tracks, car staging, paddocks, motorcycle tracks and Gymkhanas, as well as stadiums, special events, sports fields and athletic facilities for player safety, crowd and traffic control, plus highways and roads, airports, job sites and mines. Saves time, money and increases safety in every application
- ISS Barriers are simpler, faster and more economical than other barricade systems



TecPro Barriers

- Good looking
- Supports printed advertising, easy to put on or remove (vinyl-cut graphics)
- Can be used for temporary or permanent tracks
- Space saving

Scribner Plastics

- Designed for auto ovals, road courses, motorcycles and karting
- Smooth polymer surface ideal for vinyl graphics and advertising. Bolt and nut features $\frac{3}{4}$ " NPT in top end for attaching PVC pipe or frames for flags/banners
- Permanent colorful graphics can also be molded in
- Has line of accessories to support different configurations
- Applicable to both permanent and temporary tracks
- Can also be used for crowd control, pit lanes, parking and traffic areas

SAFER Barrier

- They're like a cushion for racecars
- The investment is a capital investment that's depreciated over long term, so the cost is not as high as it initially appears. The barriers don't deteriorate over a short period of time, so they don't have to keep making the investment over and over. Impervious to sun and the elements
- Some of the barriers employ a duplex system (paint over hot-dip galvanizing) to allow multiple aesthetic finishes to match track branding

ALLEGED
NEGATIVES/REPORTED
PROBLEMS

Impact Safety Systems

- Official third party testing conducted for kart barriers only before applying the same technology to motorsports barriers
- As ISS barriers were originally established in kart racing for 11 years before the introduction of the motorsports barriers. They may still be primarily perceived as applicable to karting

TecPro Barriers

- In 10/15, barriers lifted up (like tires) and driver was buried and trapped underneath, then punctured the Armco barrier and TP barriers were very close to his head. Cranes required to lift the barriers off him. Questioning whether due to incorrect installation versus mandating lowered car noses without retesting barriers
- There is little or no information in the public domain on how the barriers should be installed
- Under scrutiny during GP2 race when accident cause prolonged red flag period due to barrier repair
- Car hitting connection point between two barrier cells can pinch cells apart, force them up and tear the straps
- After 2010 crash, driver stated that he was happy it was tires and not TP
- There is skepticism that TP is not much improvement over tires
- Barriers are designed to be placed on a flat surface, not rough or sloping as they must slip in to a groove

TecPro Barriers Cont....

- Impact location must be 90-degrees to surface in the center of the barrier for maximum safety—best for head-on crashes
- Barriers not designed to be used independently, but to work in conjunction with tires and retaining walls as part of a 3-layer barrier system
- Barriers designed to buffer a 4 or 6 row tire barrier where each stack of tires is fitted with a .30cm diameter polyethylene tube, which are in front of a guardrail or concrete wall. Entire system is 4m (approx. 13') deep
- Barriers cannot line every type of corner as they take up too much space
- If hit with enough force, plastic foam bits fly all over
- At high speeds, TP won't slow a car down enough before the next barrier, thus more sudden impact than cushiony deceleration
- Considered cost prohibitive – Too expensive to implement across every foot on every track because they include 4 layers of tires and 1 layer of Armco or concrete too. “Only tracks run by the government can afford them”

Scribner Plastics

- Barrier joint system limited to 45-degree configurations
- Must purchase additional for 6" hatch per barrier in order to add ballast
- Over/under connection can easily pop apart on impact, increase repair time and compromise safety
- Sometimes requires "rub rail" or conveyor best to stop vehicles from puncturing thin barrier walls

SAFER Barrier

- For permanent installations only, mainly on ovals
- Costly and complicated to install
- Does not lend itself to advertising/sponsorship banners
- Works well in a glancing impact, absorbing some energy without car digging in. However, Sicking himself told USA Today that tire barriers are “usually better than the SAFER barriers” when it comes to head-on and large angle impacts. SAFER is more effective for more common impacts like 45-degree angles
- Metal frame when punctured requires welding causing race stoppages
- Styrofoam must be replaced for impact absorption or, if disintegrates, it flies all over and affects car cooling systems
- Some drivers have stated they prefer tires over SAFER to protect Armco, especially in high-speed impact zones
- Some drivers say that hitting a SAFER barrier at low speed is worse than hitting a concrete wall. The wall works by giving and if you don't hit it hard enough, it doesn't give

SAFER Barrier Cont...

- In 2002, John Fitch, inventor of the Fitch Energy Absorbing Highway Barrier, called on Indy Officials to modify the SAFER barrier citing the following: Tests at angles of impact of 50-60 degrees have shown certain deficiencies; the steel tubes can be damaged, then the total barrier won't displace and absorb energy over sufficient distance; the total barrier compression of 6 to 7" is insufficient energy absorption and G reduction; the failure mode of large thin-walled boxes, which SAFER tubes are in section, is buckling; punctures in the process of repair by welding, gouging for over 20' and buckling of the tubes is evident; Polystyrene is a rigid polymer, not resilient and self-restoring. When compressed, it crushes and foam sheets must be replaced or they won't absorb crash energy, so timely restoration/replacement is crucial.
- Alternatively, the tube assembly is too rigid to bend. It would not be self-restoring if crushed by excessive forces; the 21" thickness of the foam would be marginal even if its total crash travel were to be available for energy absorption, which is not the case due to bottoming of crushed foam; the only energy absorption to date is by deformation, penetration or gashing of the tubes, and that would be limited by the 6" total width of the tubes; it specifies a steel car/barrier interface dimensioned to be impervious to damage by high angle impact, instead of the heretofore-favored conveyor belting and other non-metallic surfaces that snag and fail, which has proven to be the case; requires in-race repair by welding or time-consuming replacement of 20' tube sections, which could force cancellation of the race; If hit at the tube joint, it would lock the internal splices, preventing the replacement of the welded four-tube assembly.

SAFER Barrier Cont...

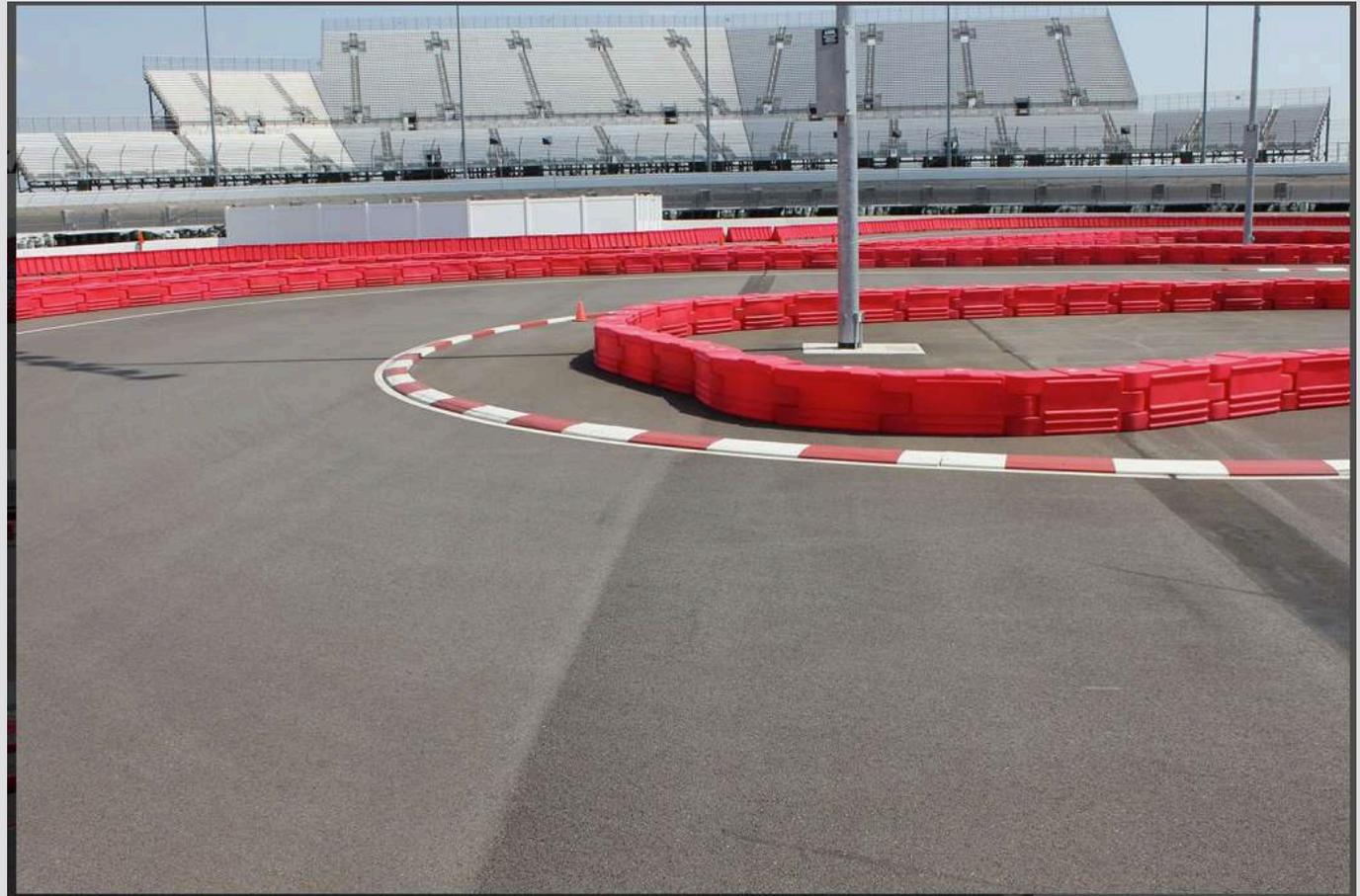
- On certain tracks, installation is difficult or not possible. The wall must have a certain capacity and extra paving is required in the area in front of the barrier and leading up to it to ensure a stable installation surface
- Construction on curved walls or tight angles at some tracks make installation an intricate process
- NASCAR only requires tracks to have SAFER barriers covering walls located at the inside corners, but barriers are not the ideal solution for all corners and all tracks, i.e. dirt
- Gate and fence configurations and the diverse racing series that compete on NASCAR-sanctioned tracks determines whether installing SAFER barriers is the right decision and it's often not and could actually be more dangerous
- Finding the materials (steel tubing) is difficult as it's only available in limited quantities
- Only 2 companies are approved to manufacture SAFER barriers, thus limiting production
- Sold by independent contractors who install and fabricate the barriers, which raises costs, plus prices vary on the steel, as well as the scope and complexity of installation at each track, and the price of raw materials and labor changes over time

Additional Notes About KARTING BARRIERS

Impact Safety Systems – KISS Barriers

- Tested and approved by FEA and proven at kart tracks for over 15 years
- Kiss barriers have become the safety barrier system of choice for both permanent and temporary kart tracks nationwide
- Offers kart track design services

Gateway Kartplex



TecPro

- One of the official barriers of the AKTPA (American Kart Track Promoters Association)
- CIK-FIA homologation
- Per the Orange County Register newspaper August 2015, at K1 Speed when racers crash into a TecPro barrier, the go-kart is captured under the barriers which rides up onto a portion of the kart and can damage the barrier or kart, and potentially harm the driver. TecPro worked well for many years, but the barriers were easily moveable and not as safe as alternative Protex

Scribner Plastics

- One of the official barriers of the AKTPA (American Kart Track Promoters Association)
- Millennium Kart Racing is the official demo site for Scribner Barrier Systems
- Per Speed51 A/O March 2015: “If you’ve been to just about any go-kart facility recently, then you’ve seen Scribner’s barrier system.”

TIRE WALLS

POTENTIAL NEGATIVES/REPORTED PROBLEMS

(In general and in comparison to other barrier methods)

Tire Walls

- Construction: Banded Tire Wall - Several stacks of used tires (bolted together into a unit or with polyethylene tubes) weighing several hundred pounds. Tires are usually guarded by a rubber conveyor belt
- Sometimes tires are painted or covered with white vinyl that's stapled to tire packs to look more presentable
- Tires present a serious Eco hazard with animals, litter, weeds, standing water, odor, mold and disease



- In the event of rain, holes must be drilled in each tire to drain in order to prevent standing water, disease and infection
- Entire crews are needed to put tire walls in place: 1000 linear meters (3281') = 18,000 tires (in 6 packs), 1,000 meters of conveyor belt, 36,000 steel bolts, 40 trucks, 8 men and 53 working days
- Restoring tires to their original state necessitates Marshals being at the accident site longer, extended safety car periods or a complete race stoppage. It can take up to 5 men to repair a tire wall, causing delays and reducing track revenue
- Tires offer no advertising or income opportunities

Tire Walls Cont...

- Tires are considered an acceptable “stopgap (band aid) or temporary solution” in certain situations, like ovals and Indycar road courses or street circuits
- Tire packs can soften the blow, but are safest when well off the racing surface. If too close to the track, tire walls can cause cars to bounce back into fast moving traffic, causing multi-car collisions. Thus, tires are not used on ovals or super speedways
- Indy racecars are open wheel and are more prone to heavy damage in collisions with tires because chassis are not protected. If cars slide under the tire wall, it can cause serious head injuries
- Even with a conveyor belt, cars can bury beneath tires (submarine), which is more dangerous in the event of a fire



- Sufficient force would dislodge tires, diminish absorption, and scatter tires potentially causing additional damage and injuries
- Some sources claims that if racecars go 190mph on long stretches and 160 on short tracks, it's too fast for a head-on into tire barriers as they don't absorb impact to the degree necessary
NOTE: Conflicts with SAFER statement

Tire Walls Cont...

- Difficult to source matching sets of used tires
- Difficult to transport, remove or store
- The average circuit replaces 300 tires per year
- Under European law, it is no longer permissible to dump car tires into landfill sites, making it extremely difficult to dispose of old track tires (however in the US, tires can be recycled, shredded or ground up to make other products)
- Some sources claim that due to increasing tire usage in the making of synthetic turf, costs are being driven up and tires are becoming more expensive



ARMCO GUARDRAILS
POTENTIAL NEGATIVES/REPORTED PROBLEMS
(In general and in comparison to other barrier methods)

ARMCO GUARDRAILS

- Armco has primarily been used to buffer concrete walls
- Armco guardrails are made of steel and not designed to withstand high speed hits without serious barricade deformation
- It is said that Armco shreds vehicles and occupants
- Fatalities due to Armco would have halted its use if not for the development of tougher race cars. Even so, guardrails have been known to impale both vehicles and drivers
- Armco offers no advertising or income opportunities



CONCRETE WALLS

POTENTIAL NEGATIVES/REPORTED PROBLEMS

(In general and in comparison to other barrier methods)

Concrete Walls

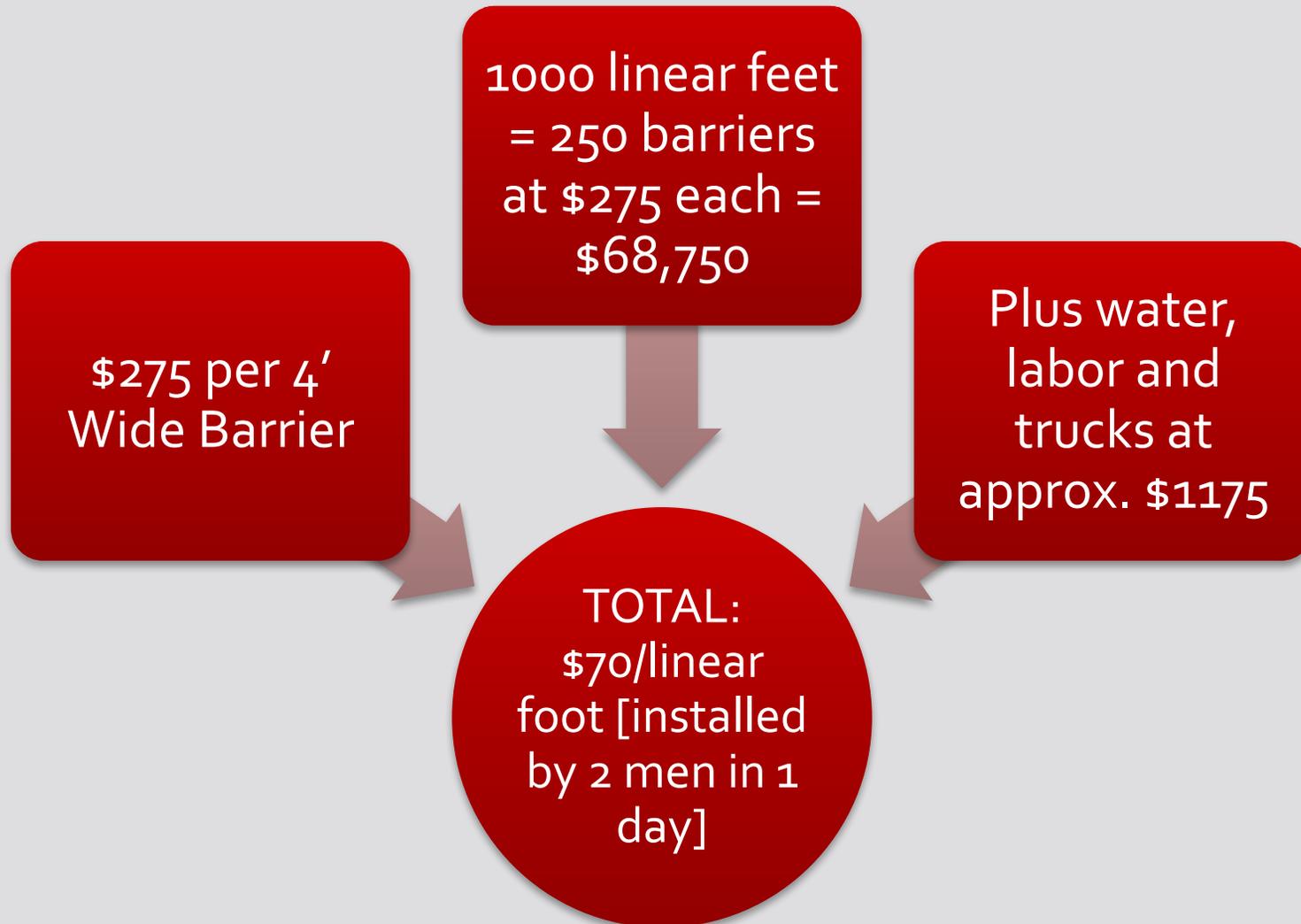
- Concrete was originally installed to protect fans, not drivers. Time and again cement has proven more dangerous to racers than any other barricade
- Cement walls are immovable, rigid and shocks the chassis when hit, potentially causing blunt force trauma, concussions or worse to the driver
- Concrete barricades weigh about 4500 pounds each, which is more than a car weighs, and offer no flexibility or give
- It is said that concrete compresses vehicles and occupants
- Concrete is extremely labor and time intensive to ship and install



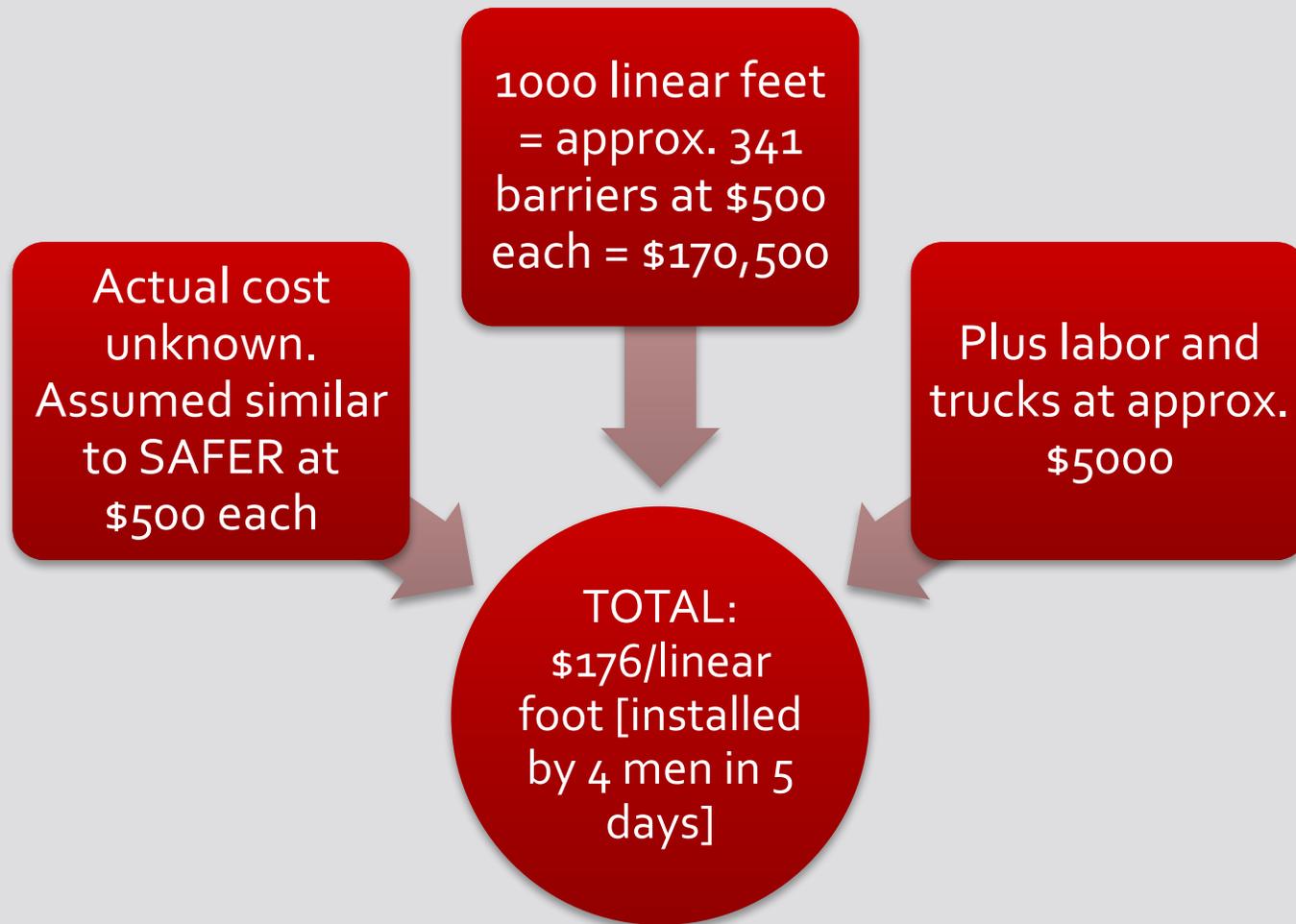
COST ANALYSIS

All Estimates Do Not Include Shipping

Impact Safety Systems

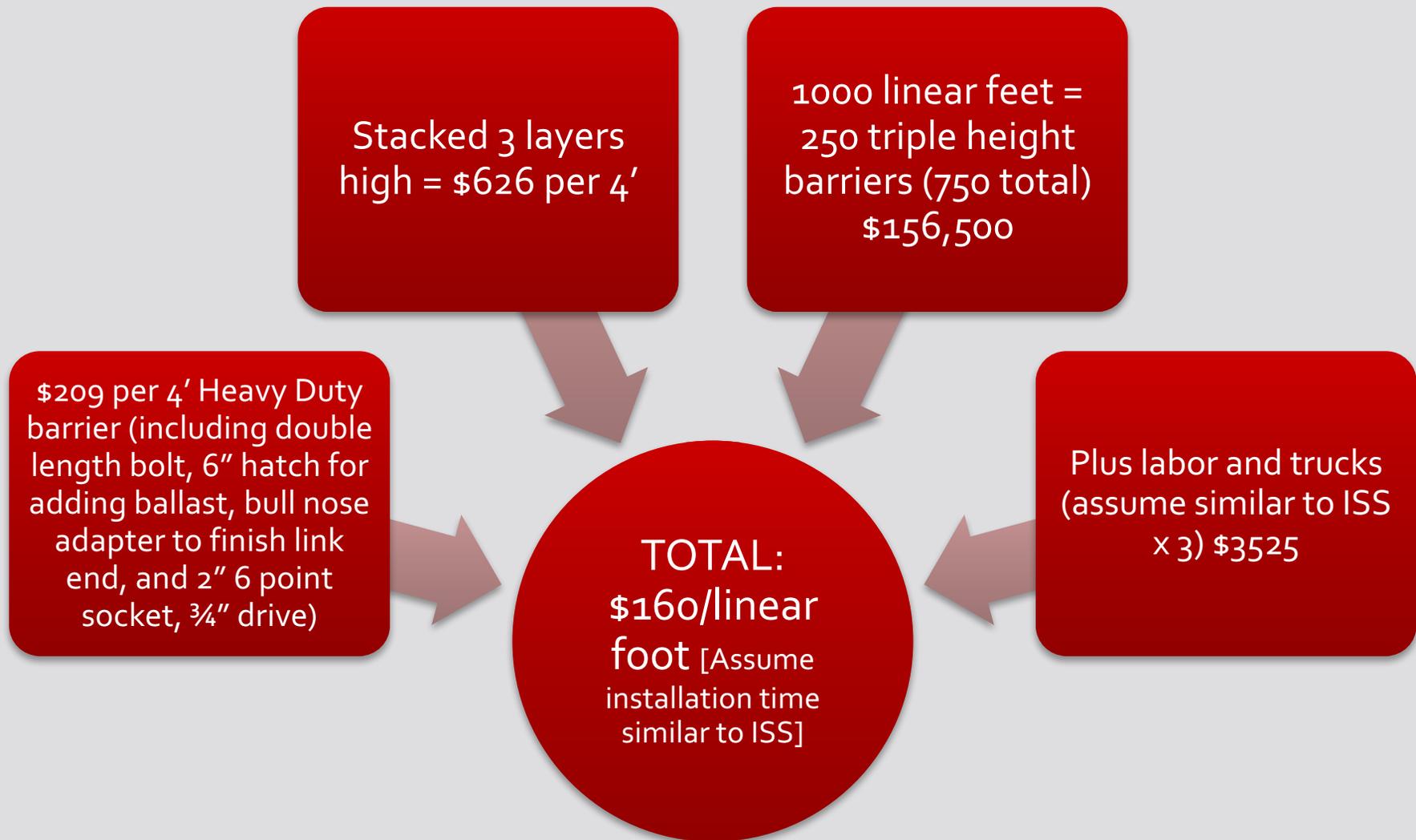


TecPro Barriers



NOTE: MUST ADD IMPORT DUTY AND TAXES OF 2.5% TO THE U.S.

Scribner Plastics



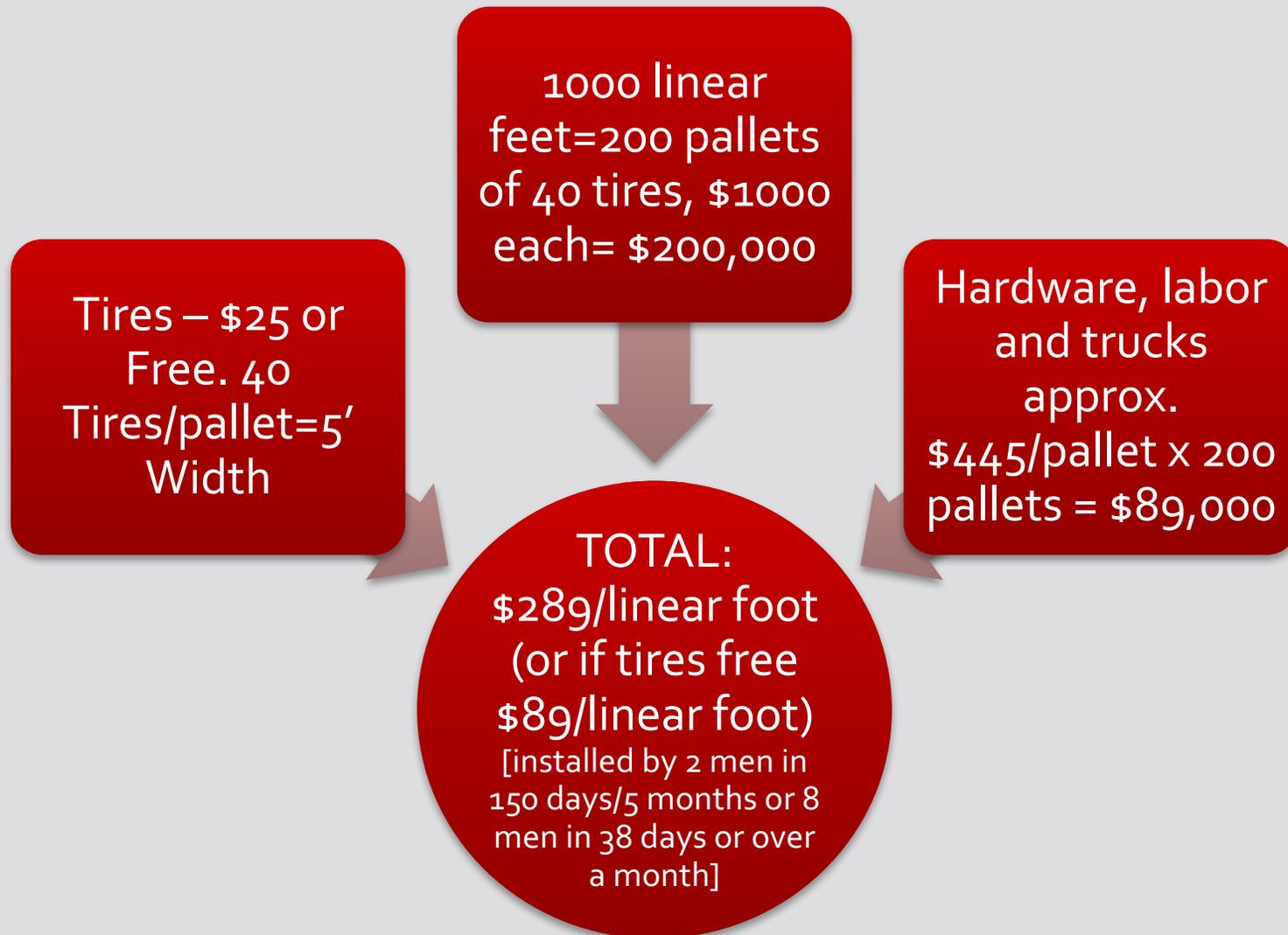
SAFER Barrier

\$500
per Linear Foot

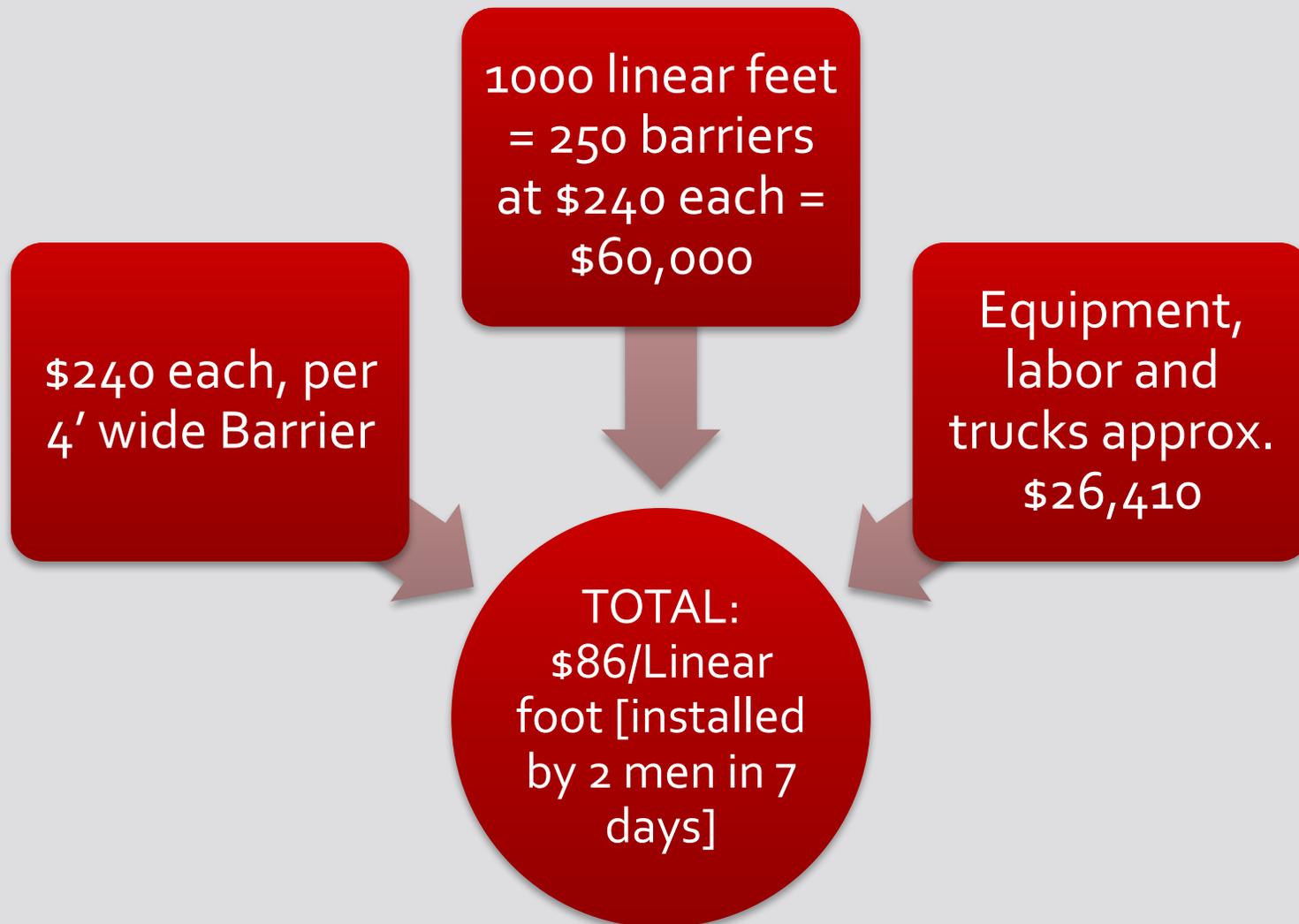
1000 linear feet=\$500,000

[Installation Labor & Time Unknown]

Tire Walls



Jersey/Concrete Barriers



CONCLUSION

Comparison of Installation, Economic & Safety Advantages for

IMPACT SAFETY SYSTEMS

ISS Installation and Cost Comparison

- ISS Barriers can be installed 5X faster than TecPro with half the number of men and cost 60% less
- ISS Barriers can cost 56% less than Scribner
- ISS Barriers can be installed much faster than SAFER and cost 86% less
- ISS Barriers can be installed 7X faster than concrete with the same number of men and cost about 18% less
- ISS Barriers can be installed up to 150X faster than tires with the same number of men and cost 75% less (or 21% less if tires free)
- ISS Barriers can raise track safety ratings, which may lower insurance premiums
- ISS Barriers greatly reduce vehicle damage—The cost to repair or replace high performance or vintage vehicles far outweighs the cost of the barriers—thus both racers and tracks reap savings benefits
- ISS Barriers are tough enough to last, substantially reducing replacement costs
- ISS Barriers are stackable for storage, cost efficient to transport, quicker to assemble with plug and play connections and easy insert anchoring pins
- ISS Barriers support advertising and sponsorship banners, which generates additional income

ISS Safety Comparison

- ISS Barriers were developed based on the same energy absorbing FEA approved technology as its smaller KISS barriers. In-depth safety testing and collision-impact research was conducted to establish original barrier design dynamics. Since applying this technology to the larger ProLink Barriers, the system's ability to dissipate impact forces has been tested and proven time and again in live scenarios on tracks for over 5 years
- ISS Barriers are designed to yield on impact, progressively retarding vehicle speed and cushioning the shock so there's less likelihood of blunt force trauma to the driver
- On severe impacts, the cumulative pull of the connected barriers creates a "snaking effect," collectively causing deceleration. When buffering, ISS keeps drivers from reaching a permanent hard wall
- Ruggedized construction, thicker composite materials, exclusive ballast weight and impact ridges for added structural integrity, stand up to high-speed hits while the unique linking system holds the barriers in place when struck and keeps them from scattering like tires, thereby minimizing hazardous debris
- Unlike other plastic barricades, ISS Barriers balance elasticity and durability so impact is absorbed and dissipated throughout the connected barriers with very little wall deformation, cracking, breaking or shattering
- ISS is the only barrier systems that offers ballast modification for varying levels of resistance. Ballast can be adjusted based on impact load speed and weight of vehicles at different locations on a track when intermittent barriers are filled with sand or water,
- Exclusive Ballast System also increases stability and makes vehicles less likely to submarine beneath the barriers, which happens frequently with tire walls

ISS Safety Comparison Cont...

- anchoring pins provide additional stabilization that reduces bounce-backs into traffic, lowering multi-vehicle collisions that often occur due to tire walls
- ISS Barriers are engineered to soften angular hits, as well as frontal/head-on
- ISS Barriers offer bright colors and directional signage options, which help raise visibility in key areas, further improving protection
- Because ISS is the ONLY Barrier System that can be used in any configuration, it provides total protection everywhere that's needed, including filling coverage gaps where other barricades can't, which makes them more versatile than tires, concrete, Armco or any other barrier method
- ISS Barriers provide more energy absorption and less bounce-back, submarining or scattering than tire walls, therefore buffering tires with a line of ISS barriers improves safety
- In higher impact areas or high speed turns, double or triple rows of ISS barriers as a buffer, either flush or 15 to 20' before concrete walls and/or Armco guardrails, is the optimum safety solution, even where tire walls already exist. This buffering method adds "crush space" and acts as the first line of defense, providing fast gradual absorption and deceleration to stop cars from reaching the last line of defense—hard walls
- To date, all ISS track customers have reported high-speed hits resulting in minimal barrier deformation, very little vehicle damage and, uppermost, drivers walked away unharmed. Thermal Club, Thompson Motor Speedway and Inde Motorsports Ranch use ISS to buffer Armco and/or concrete walls and, when combined with pavement and gravel pit, the barriers have consistently stopped vehicles from ever reaching the outer walls