Burn Injury Cost Considerations

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Introduction – Topic Overview

Burn Injury Basics

- Type of Burns – Degree of Skin Damage
- Burn Injury Mechanism
- Total Body Burn Percentage - Survivability

Burn Costs

- Direct Hospital Costs
- OHSA Fines
- Insurance Considerations
- Legal Costs
- Productivity Losses and Other Indirect Cost Considerations

Effects of PPE Choices on Burn Injury and Subsequent Costs

- Typical Work Clothing Vs. Flame Resistant PPE Protective Cost Considerations
- Flame Resistant Garment Choice Comparison

Conclusions and Summary
According to the Bureau of Labor Statistics:

...over **16,000 industrial injuries** due to burns (thermal) were reported for year 2013.

...there were **1,470 cases involving lost time from work** reported due to injuries from fires and explosions during 2013.

...of those 1,470 cases, 470 or **32%** were out of work in excess of 31 scheduled work days

...there were **148 worker fatalities** associated with fire and explosion in 2013

According to The Bureau of Labor Statistics:

Nonfatal Industrial Injuries, Resulting in Lost-Time Work Cases, Due to Fire and Explosions Have Declined Over the Last 13 Years

For the years 2000 through 2013, over 32,000 workers suffered lost-time work injuries as a result of an industrial fire or explosion

Fatal Injuries Sustained as a Result of an Industrial Fire or Explosion Have Decreased Over the Last 13 Years


For the years 2000 through 2013, close to 2,300 workers have died as a result of injuries sustained in an industrial fire or explosion.
According to The Bureau of Labor Statistics:

Despite Declining Numbers of Fatal Injuries, the Trend for Fatalities is Decreasing at a Slower Rate Than Non-Fatal Injuries

Nonfatal and Fatal Occupational Injuries due to Fire and Explosion

Medical and injury claims costs are only the tip of the iceberg…

THE TIP OF THE ICEBERG
Direct Costs of Injuries

Medical costs
Wage indemnity
Claims and administration fees

THE BULK OF THE ICEBERG
Additional Costs of Injuries

General Liability Costs & Litigation
Lost Productivity and Quality
Production Interruptions, Yield Losses
Replacement Labor / Overtime
Insurance Premiums
Damage to Customer Relations
Damage to Public Image and Brands
Potential OHSA Fines
Opportunity Costs

Data Source: International Association of Oil and Gas Producers, Liberty Mutual Safety Index
Skin has three layers:

**The Epidermis** - the outermost layer of skin
- Provides a waterproof and protective barrier
- Generates new skin cells
- Creates melanin (skin color).

**The Dermis** - beneath the epidermis
- Contains tough connective tissue
- Hair follicles
- Nerve endings
- Blood capillaries
- Sweat and oil glands.

**Subcutaneous Tissue (Hypodermis)** – The bottom or deeper layer
- Made of fat and connective tissue attaching the dermis to your muscles and bones
- Blood vessels
- Additional nerve endings
- Temperature regulation for the body.

*Source: [http://intranet.tdmu.edu.ua/](http://intranet.tdmu.edu.ua/)*
Burn Injury Fundamentals

Fire Exposure Energy
- Units Are cal/cm² (calories per square centimeter)
- 1 cal/cm² Is Equivalent to the Energy Produced by a Cigarette Lighter in One Second on Tip of a Finger
- 2nd degree burns result from 1 to 2 cal/cm² exposure

Skin Temperature Effects
- Normal Skin Temperature ~90.5°F (32.5°C)
- Burn Injury Begins when Basal Layer (80-100µm) > ~111.2°F (44.0°C)
- Time to Injury Depends on Duration & Energy Input
- Degree of injury dependent on depth of tissue damage
- Acceleration Occurs as Skin Temp Increases
- Skin Destroyed Instantly when Basal Layer > 158°F (70.0°C)

Skin Burn
- Onset @ > 44 °C (111 °F) skin temp
- Instantaneous @ 72 °C (162 °F) skin temp
**1st Degree:**
Skin Becomes Red, No Blister

**2nd Degree Or Partial Thickness Burn:**
Skin Blisters, Epidermis Must Regenerate
~100 Microns In Depth

**3rd Degree Or Full Thickness Burn:**
Full Thickness Of Skin Destroyed, Skin Can Not Regenerate, Scar Tissue Forms
1,000 to 2,000 Microns In Depth  
(thickness of a dime)

**4th Degree:**
Muscle And Bone Are Damaged

**Source:** http://www.glenoaks.edu
Burn Injury Fundamentals

Most Fire Exposures Will Cause Burn Injury To Exposed Skin and Ignite Flammable Clothing

Thermal or Heat Energy From The Fire Is Transferred Onto the Garment

Even After The Victim Escapes The Event, The Garments Continue to Transfer Residual Heat Onto The Skin.

Clothed areas can be more severely burned than exposed skin!
Burn % vs Time – FR Single layer Garment
Thermal Manikin ASTM F 1930

Burn Injury Fundamentals

Burner Shut-off
Chances of surviving a fire decrease...

- Burn Injury
- Age

Data Source: American Burn Association 2011 study
Work-related fatalities can cost a company millions of dollars and while may only happen in rare events, burn injuries are neither cheap nor uncommon.

380,000

Americans suffer from burn injuries every year.

$10.4 billion

Spent on burn injury treatments alone.

In addition to direct costs associated with recovery from burn injuries, victims may suffer from chronic pain and scarring, and may experience anxiety, depression, or other psychological symptoms.

Some workers may not be able to return to their pre-injury job.

Employers realize the costs, for their injured employees, associated with lost productivity, reduced competitiveness, employee rehiring and retraining, as well being subject to increases in workers’ compensation premiums.

Data Source: National Business Group on Health
A Single Burn Injury Can Cost Millions

Burn injuries of 40% - 60% body burn*

- Average hospital stay duration
  - **54 Days** (survivor)
  - **21 days** (fatality)

- Average cost of hospital stay
  → **$780,000** (survivor)

- Additional Costs: lawsuits, productivity losses, OSHA fines, insurance claims

*A well designed and executed FR PPE program can potentially cost significantly less than a single burn injury claim

*Source: American Burn Association
National Burn Repository® 2013
While it’s difficult to capture the full impact of work-related burn injuries in a measured cost to companies, we will review data, actual examples, and other considerations to illustrate the potential magnitude of impact.

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
Hospital and medical costs can vary significantly based on the extent of burn injuries

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
Hospital Costs – Depending on the % total body burn, hospital costs can be upwards of $1MM.

Source: 2014 National Burn Registry Annual Report

On Average:
1 day spent in the hospital for every 1% body burn
Hospital Costs – Even fatal burn injuries can carry high hospitalization costs.

Fatality - Hospital Cost

Source: 2014 National Burn Registry Annual Report
Industrial injuries and fatalities typically trigger OHSA investigations. Significant fines as a result of violation findings are well documented.

**Burn Injury Cost Considerations**

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
OSHA Fines

Fines can vary, based on the severity and frequency of the safety violations.

On December 28, 2012, two Environmental Enterprises Inc. employees were severely burned, one fatally. OSHA determined the cause of the fire and explosion to be the ignition of an organic industrial filter cartridge filled with sodium chlorate, a strong oxidizer. The likely source of the ignition was an electrically-powered reciprocating saw that the employees received permission to use to remove metal end caps and mesh from the filter. Among the citations were two willful citations based on the use of incorrect PPE type for the identified hazard and lack of employee training on proper use of PPE for the identified hazard.

OSHA has proposed fines of $325,710

On March 23, 2005, thirteen employees were injured in an explosion at the BP Texas City Refinery ISOM Unit. Seven of the employees were hospitalized and treated for burns, while six employees were treated for cut and laceration but were not hospitalized.

Current Penalty Stands at $21,156,500

Source: OSHA
## Burn Injury Cost Considerations

The top 25 OHSA enforcement cases total fines in the amount of $230,050,440

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Inspection #</th>
<th>Issuance Date</th>
<th>Total Issued Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BP Products North America</td>
<td>311926274 308314620</td>
<td>10/29/2009</td>
<td>$81,340,000</td>
</tr>
<tr>
<td>2. BP Products North America</td>
<td>268241940 268241088</td>
<td>09/21/2005</td>
<td>$21,361,500</td>
</tr>
<tr>
<td>3. IMC Fertilizer/Angus Chemical</td>
<td>107607663 107607871</td>
<td>10/31/1991</td>
<td>$11,550,000</td>
</tr>
<tr>
<td>4. Imperial Sugar</td>
<td>310998712 311522658</td>
<td>07/25/2008</td>
<td>$8,777,500</td>
</tr>
<tr>
<td>5. O&amp;G Industries, Inc.*</td>
<td>109179937 314295460</td>
<td>08/03/2010</td>
<td>$8,347,000</td>
</tr>
<tr>
<td>6. Samsung Guam, Inc.</td>
<td>107329740 106196601</td>
<td>09/21/1995</td>
<td>$8,250,000</td>
</tr>
<tr>
<td>7. CITGO Petroleum</td>
<td>110416880</td>
<td>08/29/1991</td>
<td>$8,155,000</td>
</tr>
<tr>
<td>8. Dayton Tire</td>
<td>109051648</td>
<td>04/18/1994</td>
<td>$7,490,000</td>
</tr>
<tr>
<td>10. Keystone Construction Maintenance*</td>
<td>109179204 314295445</td>
<td>08/03/2010</td>
<td>$5,623,000</td>
</tr>
<tr>
<td>11. Philip Go/Fish Engineering</td>
<td>106612443 107355515</td>
<td>04/19/1990</td>
<td>$6,395,200</td>
</tr>
<tr>
<td>12. Hercules, Inc.</td>
<td>108662428 100490705</td>
<td>09/08/1993</td>
<td>$6,328,000</td>
</tr>
<tr>
<td>13. Arcadion</td>
<td>102281292 102281128</td>
<td>01/27/1993</td>
<td>$5,085,000</td>
</tr>
<tr>
<td>14. E. Smals Painting</td>
<td>108753690</td>
<td>06/03/1994</td>
<td>$5,008,500</td>
</tr>
<tr>
<td>18. Dacosta Egg Farms (aka Maine Contract Farming, LLC)</td>
<td>122375512</td>
<td>07/12/1996</td>
<td>$3,555,500</td>
</tr>
<tr>
<td>19. Arco Chemical Co.</td>
<td>110319854</td>
<td>01/03/1999</td>
<td>$3,481,300</td>
</tr>
<tr>
<td>20. The Budd Company</td>
<td>10825510</td>
<td>12/12/1989</td>
<td>$3,345,000</td>
</tr>
<tr>
<td>22. IBP</td>
<td>100005651</td>
<td>05/11/1998</td>
<td>$3,133,100</td>
</tr>
<tr>
<td>23. BP North America Inc. and BP Husky Refining LLC's Refinery</td>
<td>311611081</td>
<td>02/08/2010</td>
<td>$3,042,000</td>
</tr>
<tr>
<td>24. Shell Oil Chemical Co.</td>
<td>103342093</td>
<td>11/22/1994</td>
<td>$3,017,000</td>
</tr>
<tr>
<td>25. Union Carbide</td>
<td>110398310</td>
<td>09/12/1991</td>
<td>$2,803,500</td>
</tr>
</tbody>
</table>

Source: https://www.osha.gov/dep/enforcement/top_cases.html

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Self-Insured companies certainly bare the full cost impact of serious burn injuries. Even companies with worker’s compensation insurance can realize significant additional costs.

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
Those enrolled in worker’s compensation insurance plans must consider the impact a claim will have on their “Experience Modification Rating” and subsequent effect on insurance premiums.

Experience Modification Rating

- Frequency and aggregate cost of claims drive changes in the rating below and above 1.0
- EMR of 1.0 is considered “average” within the grouping of like companies
- EMR over 1.25 is considered high and could force a company out of a state’s general plan and into a specially funded assigned risk plan
- Assigned risk plan could result in premium costs rising by a factor of 1.5 to 2.0

Estimates suggest more than 6,000 corporations and their subsidiaries nationwide operate self-insured Workers' Compensation programs

Source: Self Insurance Institute of America, Inc.

Differences exist in Worker’s Compensation Insurance plan coverages based on the state and extent of coverage.
Construction company has a base premium (before application of the EMR and other credits) of $160,000 with no recent claims, resulting in a claim free EMR. The claim free EMR is 0.66 (66%), which means their premium for workers’ compensation coverage that year was $105,600.

Company has a single claim, broken arm. Direct costs of the claim is $50,000. EMR increased 15 points resulting in a premium increase of $24,000 to $129,600. This claim stayed in their experience modification formula for 3 years.

In other words, this $50,000 claim will ultimately end up costing the company $72,000 in additional insurance premiums. In addition to this, you have another $55,000 in indirect costs making the total cost of this claim $127,000! If your company has a 10% profit margin, you will need to generate an additional $1,270,000 in revenues to cover these costs.
Lawsuits on the behalf of serious and fatally injured workers and subsequent large jury awards and settlements are well documented.

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
The greatest costs associated with burn injuries potentially could be a result of lawsuits.

Some examples…

- **$5,000,000** burn injury settlement over fuel system failure
- **$1,600,000** settlement for burns sustained on the job requiring arm and hand skin grafts
- **$375,000** wrongful death and burn injury settlement over gas tank fire
- **$122,500,000** burn injury verdict resulting from refinery explosion and negligence
- **$7,500,000** settlement for product liability case, where victim suffered burns on over 90% of his body

Source: Various Law Firm Case Reports
Litigation Costs

A study conducted by the Vanderbilt University Law School found:

- Average settlement or award in burn injury cases equaled $827,506.
- The cost to defend these cases amounted to $0.83 for every dollar paid for claims in which a suit was filed.
- Thus, the average cost to defend these cases was close to an additional $690,000 above the amount paid to the injured party.

A single lawsuit can financially burden a company for many years rendering them less competitive, and in some cases bankrupt as a direct result of the costs involved.

As a result, many companies will settle. A Harvard Law study found that even in settlement cases, the cost of litigation is proportional to the settlement amount.

Productivity losses can result in significant costs to a company that would not necessarily be readily apparent.

- Hospital Costs
- OSHA Fines
- Insurance Claims/Premiums
- Legal Costs
- Productivity Losses
- PPE Choices
Burn Injury Cost Considerations

Lost Productivity Costs

- Loss of experience and training
- Cost of re-training
- Less effective or inefficient back-fill workers
- Re-allocation of resources, minimizing effectiveness in other areas
- Production delays
- Employee Moral
- Attention on accident recovery, investigations, OHSA inspections
Productivity losses due to fires and burns are highest among males ages 24-44 and females ages 45-65 – ranges including much of the active workforce.

**Estimated Injury Contributing Cost**

**Percentage**

- Wage and Productivity Losses: 45.9%
- Medical Expenses: 27.7%
- Administrative Expenses: 18.1%
- Other Costs: 8.3%

Source: National Safety Council Injury Facts 2013
Burn Injury Cost Considerations

Other Costs to Consider...

- Continued Insurance claims – Permanent Disability
- Damage to Customer Relations
- Public Image
- Damage to Brands
- Opportunity Costs
- Competitive Disadvantages

57% of burn cases can cost up to $100,000 for psychological treatment.

Source: National Business Group on Health
What is the potential total cost for a single burn injury event?

Even while being conservative with the estimated individual cost components, a typical burn injury case can cost nearly **$5,000,000** per person.

Imagine the total cost if there were a large fire or incident in which multiple workers were affected…
To aid companies in realizing the financial impact an injury can have on a business...

OSHA developed an online Injury Cost Calculator to estimate the cost of injuries to your company.

Estimated Costs of Occupational Injuries and Illnesses and Estimated Impact on a Company's Profitability Worksheet

Employers can use the "safety Pays" to assess the impact of occupational injuries and illnesses on their profitability. This program uses a company's profit margin, the average costs of an injury or illness, and an indirect cost multiplier to project the amount of sales a company would need to generate to cover these costs. The program is intended as a tool to raise awareness of how occupational injuries and illnesses can impact a company's profitability, not to provide a detailed analysis of a particular company's occupational injury and illness costs. Your local OSHA On-site Consultation Office can help small businesses identify workplace hazards and develop and implement an effective injury and illness prevention program.

Direct Costs

1. Select an injury type from the drop-down menu OR enter the total workers' compensation costs.
2. Enter the profit margin (leave blank to use default of 3%).
3. Enter the number of injuries (leave blank to use default of one).
4. Select "Add/Calculate" to compute the total direct and indirect costs.
5. Repeat the step to add additional injuries to the list.

Revenue Generation Needed to Cover Injury Costs

Example: Worker at a company suffers a burn injury. Direct costs are paid in the amount of $850,000 as a result of the accident. Assume the company averages a net profit of 10%.

The company would need to generate $8,500,000 dollars worth of additional revenues to fully cover the costs paid for a single burn injury.

Regardless of their ability to generate additional revenue, they will have realized an Opportunity Cost of $850,000.

Opportunity Cost:

A benefit, profit, or value of something that must be given up to acquire or achieve something else. Since every resource (land, money, time, etc.) can be put to alternative uses, every action, choice, or decision has an associated opportunity cost.

Source: www.businessdictionary.com

What opportunities would your company have to forego as a result of paying millions for an injurious event?
We have seen how burn injury costs have the potential to cost millions of dollars...

*How does your choice of PPE affect these costs?*
Actual Garment Evaluations

Fire - THERMAL MANIKIN TEST (ASTM F 1930)

- Developed by U.S. Military and DuPont
- Used to Qualify Garments as part of NFPA 2112
  - Pass / Fail Assessment at (6 cal/cm² Exposure)
  - Total Predicted Burn Injury (TPBI) must fall below 50%
- Evaluate Clothing to a Recognized Hazard
- Average of 3 Exposures
- Sensors Measure Transmitted Heat
  - Collects data for 60 seconds (@ 10 times a second)
  - Predicted Burn Injury & Probability of Survival
- Jet Fire Exposure
  - Variable Duration & Heat Flux
  - Simulate various exposure possibilities
Nomex® IIIA Coverall vs. Typical Non-FR Cotton Work Wear

Thermal Manikin before and during an ASTM F1930 exposure

*Total 6 cal/cm² - 2 cal/cm²s heat flux @ 3 seconds*

*NFPA 2112 minimum requirement*
**Burn Injury Cost Considerations**

**Predicted Burn Injury Cost Representation**

### NOMEX® IIIA, 6 oz/yd²

- 3 seconds @ 2.0 cal/cm²s
- Total Exposure: 6.0 cal/cm²
- **Predicted Burn Injury: 10.7%**

### 100% Non-FR Cotton Shirt and NON-FR Cotton Jeans

- 3 seconds @ 2.0 cal/cm²s
- Total Exposure: 6.0 cal/cm²
- **Predicted Burn Injury: 86.9%**
NOMEX® IIIA, 6 oz/yd²

- 3 seconds @ 2.0 cal/cm²s
- Total Exposure: 6.0 cal/cm²
- Predicted Burn Injury: 10.7%

100% Non-FR Cotton Shirt and NON-FR Cotton Jeans

- 3 seconds @ 2.0 cal/cm²s
- Total Exposure: 6.0 cal/cm²
- Predicted Burn Injury: 86.9%
**Burn Injury Cost Considerations**

**Nomex® vs. Typical Non-FR Cotton Workwear**

**Survivor Hospital Cost**

- **Potential $1,000,000 additional costs per case**

**Background Hospital Cost Data Source:** 2014 National Burn Registry Annual Report
Nomex® IIIA Coverall vs. FR Treated 88/12 Cotton/Nylon

Thermal Manikin before and during an ASTM F1930 exposure

Total 8 cal/cm² - 2 cal/cm²s heat flux @ 4 seconds
- 2.66 cal/cm²s heat flux @ 3 seconds
Burn Injury Cost Considerations

Predicted Burn Injury Cost Representation

**NOMEX® IIIA, 6 oz/yd²**
- 4 seconds @ 2.0 cal/cm²s
- Total Exposure: 8.0 cal/cm²
- **Predicted Burn Injury: 34.4%**

**88/12 FR Treated Cotton / Nylon, 7 oz/yd²**
- 4 seconds @ 2.0 cal/cm²s
- Total Exposure: 8.0 cal/cm²
- **Predicted Burn Injury: 69.7%**
NOMEX® IIIA, 6 oz/yd²
- 4 seconds @ 2.0 cal/cm²s
- Total Exposure: 8.0 cal/cm²
- Predicted Burn Injury: 34.4%

88/12 FR Treated Cotton / Nylon, 7 oz/yd²
- 4 seconds @ 2.0 cal/cm²s
- Total Exposure: 8.0 cal/cm²
- Predicted Burn Injury: 69.7%
Burn Injury Cost Considerations

Nomex® vs. FR Treated Cotton 88/12

Survivor Hospital Cost

Potential $650,000 additional costs per case for FR Treated Cotton 88/12

Background Hospital Cost Data Source: 2014 National Burn Registry Annual Report

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PPE Choices

- NFPA 2113 - Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures From Fire

- Hazard Risk Analysis
- Wearer Comfort
- Durability
  - Flame Resistant Properties
  - Wear Properties and Wear Life
- Cost Considerations
  - Initial Cost vs. Total Life Cycle Cost
- Ease of Care and Long Term Appearance

Is Your Current PPE Program Optimized For All Important Characteristics?
Conclusions and Summary

**Burn Injuries Generate Significant Direct and Indirect Costs**

- Indirect burn injury costs can greatly exceed direct costs
- Many burn injuries result in long-term physiological and psychological impairment
- Upfront costs of a PPE program are a small consideration compared to a single injury claim
- Poor PPE choices can result in an unanticipated financial burden to a company
- Proper PPE choices can help save lives, reduce potential injuries, and reduce potential long-term costs

**Be Prepared for the Worst Case Scenario, Not the Best.**
Be Prepared for the Worst Case Scenario, Not the Best.