

# Advanced Cybersecurity Risk Quantification

Reg NO: 2025/GRC/11032

## Task 1: Calculate Annualized Loss Expectancy (ALE)

### Vulnerability 1: API Authentication Bypass

ALE = Single Loss Expectancy x Annual Rate of Occurrence

- Maximum single incident loss = \$5,000,000
- Exploit probability = 15% ---- 0.15 {decimal}

SLE = 5,000,000

ARO = 0.15

ALE = SLE X ARO = 5,000,000 X 0.15 = 750,000

### Vulnerability 2: Database Injection Vulnerability

- Record at risk = 500,000
- Cost post record = \$250
- Exploit probability = 25% – 0.25 {decimal}

SLE = 500,000 X 250 = 125,000,000

ARO = 0.25

ALE = SLE X ARO ---- 125,000,000 X 0.25 = 31,250,000

### Vulnerability 3: Session Hijacking

- Account at risk = 5,000
- Loss per account = \$1500

- Exploit probability = 40% — 0.40 {decimal}

$$\text{SLE} = 5,000 \times 1500 = 7,500,000$$

$$\text{ARO} = 0.40$$

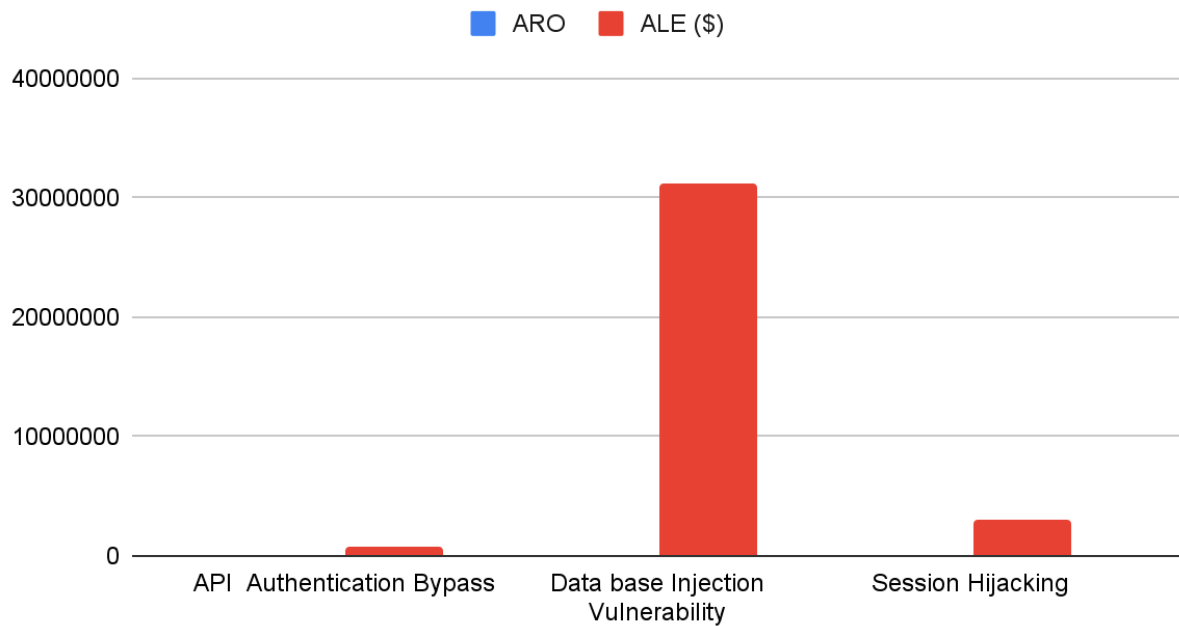
$$\text{ALE} = \text{SLE} \times \text{ARO} \text{ — } 7,500,000 \times 0.40 = 3,000,000$$

## Task 2: Prioritize Risks

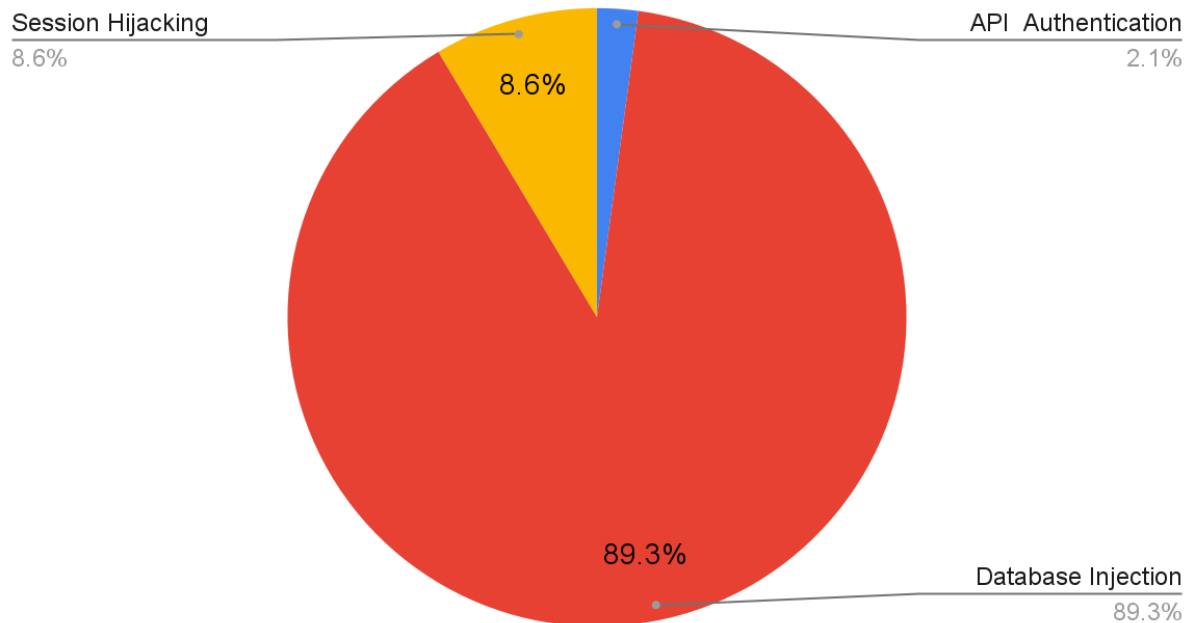
Vulnerability	SLE	ARO	ALE	Risk priority level
Data Base Injection Vulnerability	\$125,000,000	0.25%	\$31,250,000	High
Session Hijacking	\$7,500,000	0.40%	\$3,000,000	Medium
API Authentication Bypass	\$5,000,000	0.15%	\$750,000	Low

## Task 3: Create Risk Visualization

## ALE Per Vulnerability Status



## Risk Distribution by ALE



- Develop a risk heat map (High/Medium/Low) based on probability and impact

A	B	C	D	E	
Vulnerability	Probability [ARO]	Impact [SLE \$]	Risk Level		
API Authentication Bypass	0.15	\$5,000,000.00	Low		
Database Injection	0.25	\$125,000,000.00	High		
Session Hijacking	0.4	\$7,500,000.00	Medium		

## Phase 2: Control Evaluation

### 1. Advanced API Security Gateway

- Initial investment: \$350,000
- Maintenance: \$50,000/year
- Effectiveness: 90% {0.90} reduction in API Vulnerability

### 2. Web Application Firewall {WAF}

- Initial investment :\$150,000
- Maintenance :\$25,000/year
- Effectiveness: 75% {0.75} reduction in web vulnerabilities

### 3 Multi- Factor Authentication Enhancement

- Initial investment: \$200,000
- Maintenance: \$30,000/year
- Effectiveness: 95% {0.95} reduction in account takeover

## Risk Reduction

- **Advanced API Security Gateway**

*Risk reduction = ALE X Control Effectiveness*

$$\$750,000 \times 0.90 = \$675,000$$

- **Web Application Firewall {WAF}**

*Risk reduction = ALE X Control Effectiveness*

$$\$31,250,000 \times 0.75 = \$23,437,500$$

- **MFA Enhancement**

*Risk reduction = ALE X Control Effectiveness*

$$\$3,000,000 \times 0.95 = \$2,850,000$$

## Return on Investment {ROI}

*ROI = Risk Reduction / initial investment + Maintenance*

**API security gateway**—  $\$675,000 / \{\$350,000 + \$50,000\}$

$$\$675,000 / \$400,000 = 1.6875 \text{ \{ multiply by 100\}}$$

$$= 168.75\%$$

**Web Application Firewall**—  $\$23,437,500 / \{\$150,000 + \$25,000\}$

$$\$23,437,500 / \$175,000 = 133.9285714$$

$$= 13,392.86\%$$

**Multi-Factor Authentication Enhancement**—  $\$2,850,000 / \{\$200,000 + \$30,000\}$

$$\begin{aligned} &\$2,850.00 / \$230,000 = 12.3913043 \\ &= 1,239.13\% \end{aligned}$$

## Payback Period

*Payback period = Initial Investment / Risk Reduction*

**Advanced API Security Gateway**— 350,000 / 675,000 = 0.5185— 0.52yrs

{convert to days} 0.52 x 365 = 189.8days— 190days

**Web Application Firewall**— 150,000 / 23,437,500 = 0.0064years

0.0064 x 365 = 2.34days— 2days

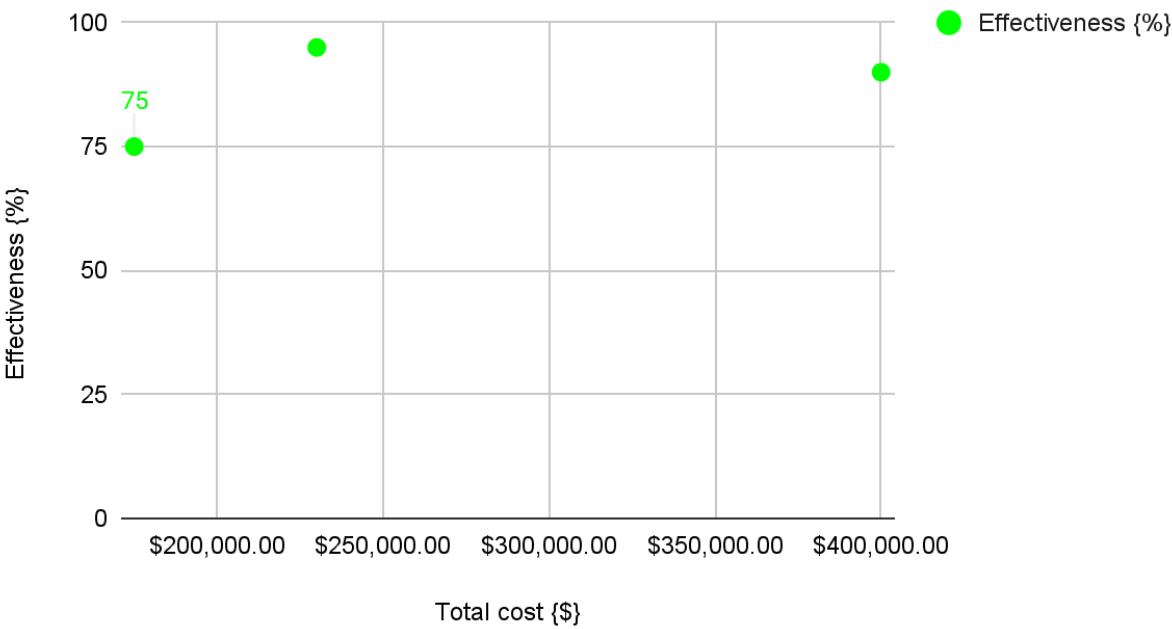
**MFA Enhancement**— 200,000 / 2,850,000 = 0.070175 — 0.07 years

0.07 x 365 = 25.55days — 26days

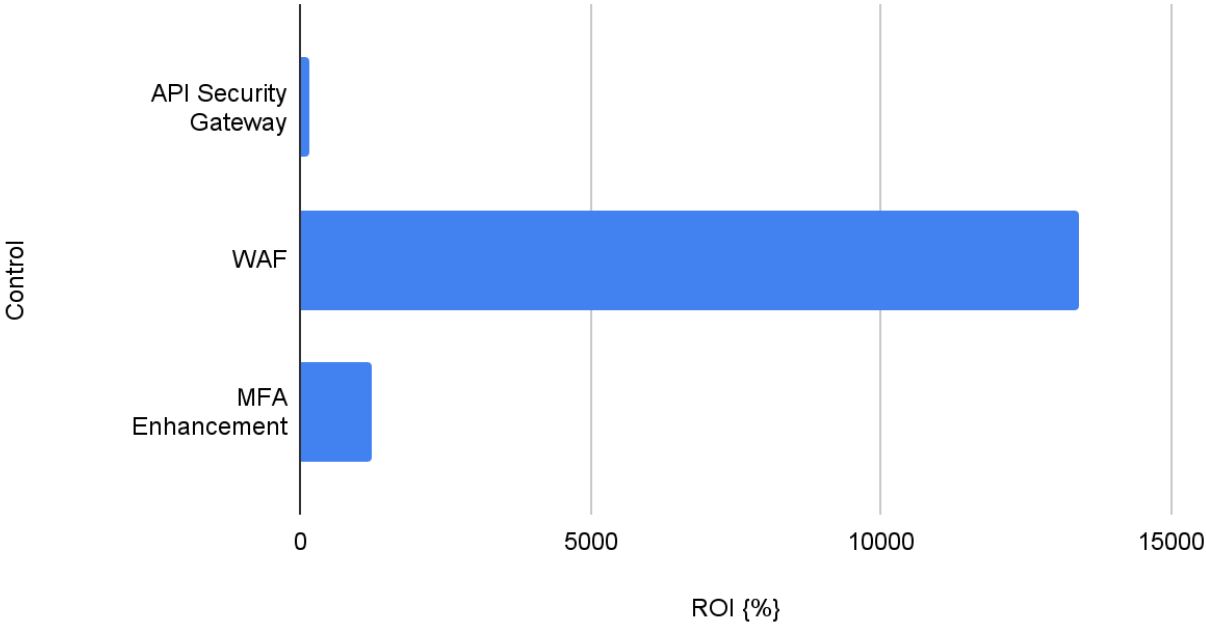
Control option	Initial investment	Annual maintenance	Risk reduction	ROI	Payback period {years}
Advanced API security gateway	\$350,000	\$50,000	\$675,000	168.75%	0.52years
Web application firewall {WAF}	\$150,00	\$25,000	\$23,437,500	13,392.86%	0.0064years
Multi-factor authentication	\$200,000	\$30,000	\$2,850,000	1,239.13%	0.07years

Task 5: Control Selection Analysis

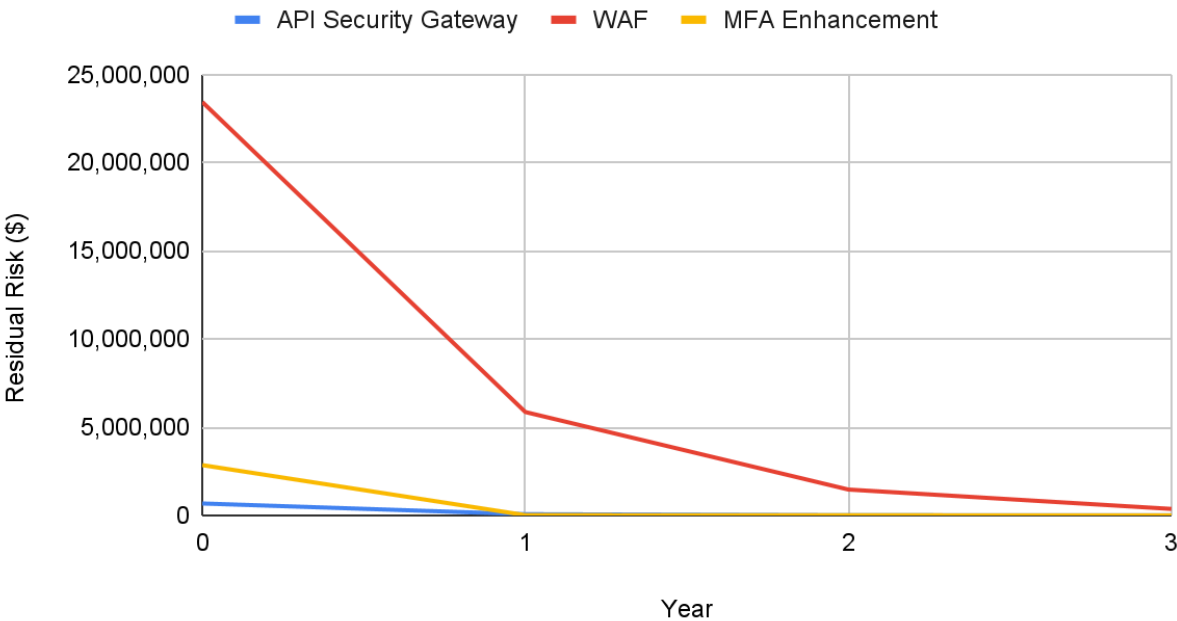
Control Cost vs Effectiveness



## ROI Comparison Across Controls



## Risk Reduction Over Time





## Phase 3: Executive Reporting

### Executive Risk Dashboard – SecureBank

#### Top 3 Risk with Financial Impact

- Database Injection—\$33.25m {High}
- Session Hijacking—\$3m {Medium}
- API Authentication Bypass—\$750K {Low}

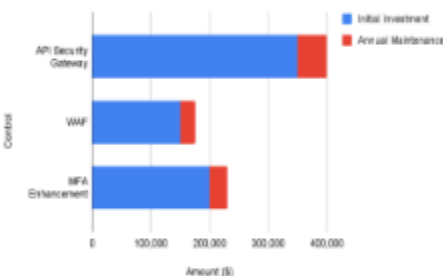
#### Controls with Costs

- Web Application Firewall—\$150k initial + \$25k Annual
- Multi-Factor Authentication—\$200k initial + \$30k Annual
- API Security Gateway—\$350k initial \$50k Annual

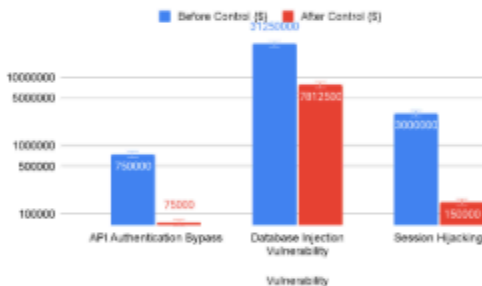
#### Expected Risk Reduction & ROI

- WAF— \$23.4m Reduction, ROI = 13,392%
- MFA - \$2.85m Reduction, ROI = 1,239%
- API Gateway—\$675k Reduction, Roi = 169%

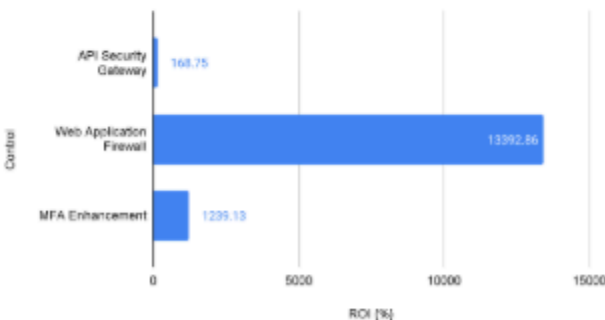
Control Investment Breakdown



Risk Exposure Before vs After Controls



ROI Comparison Across Controls



## Executive Dashboard Summary

The top three risks identified are Database Injection, Session Hijacking, and API Authentication Bypass, with Database Injection having the highest financial impact.

The Risk Exposure (Before vs After Controls) chart shows that applying controls greatly reduces overall risk levels.

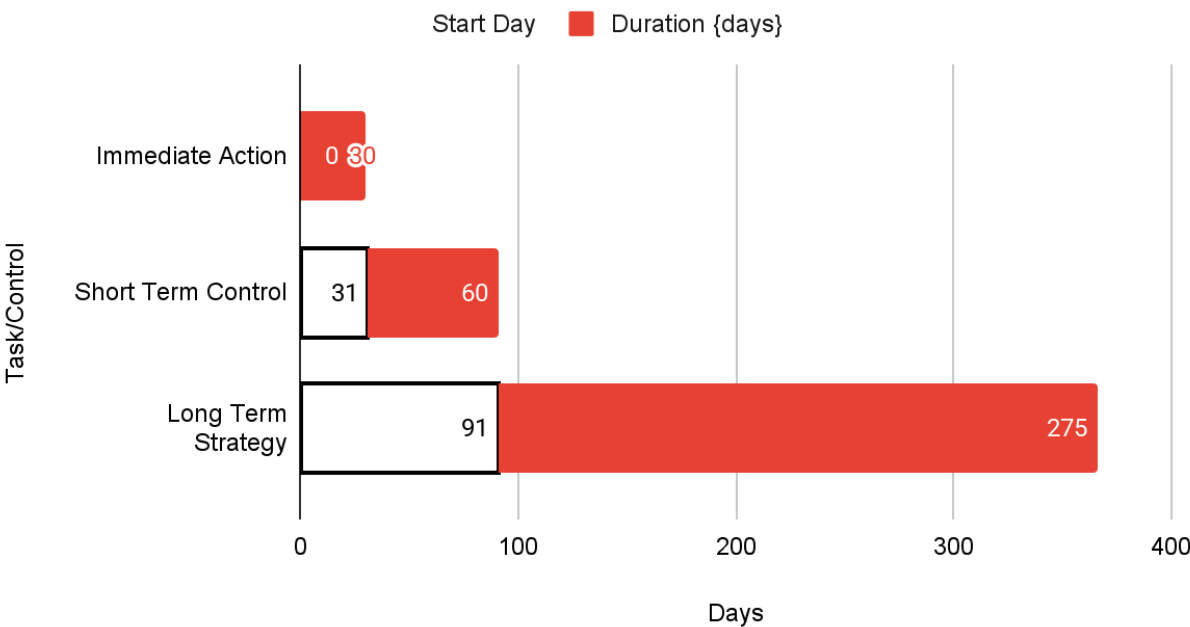
The Control Investment Breakdown chart highlights how much was spent on each security control.

The ROI Comparison chart shows that WAF and MFA provide the highest return on investment while staying within the available budget.

Overall, the controls implemented help reduce the company’s total risk exposure and improve security posture in a cost-effective way.

## Task 7: Risk Treatment Timeline

### Risk Treatment Timeline



## Bonus Challenge:

### Combined Risk-Control Matrix

*Residual Risk = Current Risk – Risk Reduction*

Vulnerability	Current Risk {ALE}	Control Applied	Risk Reduction	Residual Risk	Control cost {initial+ maintenance}
API Authentication Bypass	\$750,000	Advanced API security Gateway	\$675,000	\$75,000	\$350,000+\$50,000 = \$400,000
Database Injection Vulnerability	\$31,250,000	Web Application Firewall [WAF]	\$23,437,500	\$7,812,500	\$150,000+\$25,000 = \$175,000
Session Hijacking	\$3,000,000	Multi-Factor Authentication	\$2,850,000	\$150,000	\$200,000 + \$30,000 = \$230,000

## Control Cost vs. Risk Reduction Benefit

- **Advanced API Security Gateway** → Cost: \$350,000 → Risk Reduction: \$675,000
- **Web Application Firewall (WAF)** → Cost: \$150,000 → Risk Reduction: \$23,437,500
- **Multi-Factor Authentication (MFA)** → Cost: \$200,000 → Risk Reduction: \$2,850,000

## Optimal Control Selection Based on Budget-Constraints

- **Budget Limit:** \$500,000 {example}
- **Controls Selected Within Budget:** WAF + MAF

Total Cost = \$150,000 + \$200,000 = \$350,000

Total Risk Reduced = \$23,437,500 + \$2,850,000 = \$26,287,500

- **Residual Risk After Selection:**
- Database Injection → \$31,250,000 – \$23,437,500 = \$7,812,500
- Session Hijacking → \$3,000,000 – \$2,850,000 = \$150,000
- API Authentication Bypass → \$750,000 – \$0 = \$750,000



































































































































































































































































































































**impact**