SMART CONTRACT AUDIT REPORT

for

Deperp Governance

Prepared By: Xiaomi Huang

PeckShield

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Contact

For more information about this document and its contents, please contact PeckShield Inc.

Name	Xiaomi Huang
Phone	+86 183 5897 7782
Email	contact@peckshield.com

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1 Introduction

Given the opportunity to review the design document and related smart contract source code of the Deperp Governance protocol, we outline in the report our systematic approach to evaluate potential security issues in the smart contract implementation, expose possible semantic inconsistencies between smart contract code and design document, and provide additional suggestions or recommendations for improvement. Our results show that the given version of smart contracts is well designed and engineered, though it can be further improved by addressing our suggestions. This document outlines our audit results.

1.1 About Deperp Governance

Deperp is a decentralized derivatives exchange where participants can trade perpetual contracts on 60+ assets. The protocol combine financial innovation with the power of community and gamification mechanics to encourage active participation and ecosystem development. This audit covers its governance subsystem, which is forked from the popular Compound governance subsystem. The basic information of the audited protocol is as follows:

Table 1.1: Basic Information of Deperp Governance

Item	Description
Name	Deperp Protocol
Website	https://www.deperp.com/
Type	EVM Smart Contract
Platform	Solidity
Audit Method	Whitebox
Latest Audit Report	May 17, 2024

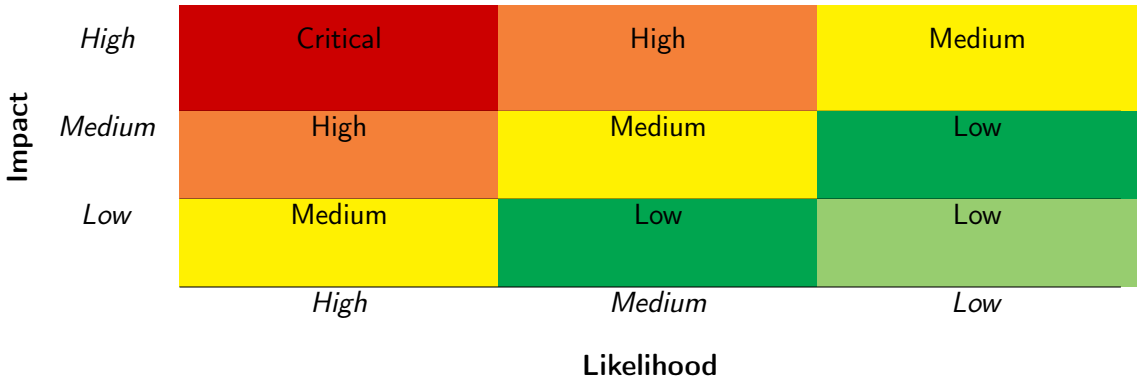
In the following, we show the Git repository of reviewed files and the commit hash value used in this audit.

- https://github.com/DePerp/deperp-governance.git (0dfc4e8)

1.2 About PeckShield

PeckShield Inc. [7] is a leading blockchain security company with the goal of elevating the security, privacy, and usability of current blockchain ecosystems by offering top-notch, industry-leading services and products (including the service of smart contract auditing). We are reachable at Telegram (https://t.me/peckshield), Twitter (http://twitter.com/peckshield), or Email (contact@peckshield.com).

Table 1.2: Vulnerability Severity Classification



1.3 Methodology

To standardize the evaluation, we define the following terminology based on the OWASP Risk Rating Methodology [6]:

- Likelihood represents how likely a particular vulnerability is to be uncovered and exploited in the wild;
- Impact measures the technical loss and business damage of a successful attack;
- Severity demonstrates the overall criticality of the risk.

Likelihood and impact are categorized into three ratings: *H*, *M* and *L*, i.e., *high*, *medium* and *low* respectively. Severity is determined by likelihood and impact and can be classified into four categories accordingly, i.e., *Critical*, *High*, *Medium*, *Low* shown in Table 1.2.

To evaluate the risk, we go through a checklist of items and each would be labeled with a severity category. For one check item, if our tool or analysis does not identify any issue, the contract is considered safe regarding the check item. For any discovered issue, we might further deploy contracts on our private testnet and run tests to confirm the findings. If necessary, we would

Table 1.3: The Full Audit Checklist

Category	Checklist Items
Basic Coding Bugs	Constructor Mismatch
	Ownership Takeover
	Redundant Fallback Function
	Overflows & Underflows
	Reentrancy
	Money-Giving Bug
	Blackhole
	Unauthorized Self-Destruct
	Revert DoS
	Unchecked External Call
	Gasless Send
	Send Instead Of Transfer
	Costly Loop
	(Unsafe) Use Of Untrusted Libraries
	(Unsafe) Use Of Predictable Variables
	Transaction Ordering Dependence
	Deprecated Uses
Semantic Consistency Checks	Semantic Consistency Checks
Advanced DeFi Scrutiny	Business Logics Review
	Functionality Checks
	Authentication Management
	Access Control & Authorization
	Oracle Security
	Digital Asset Escrow
	Kill-Switch Mechanism
	Operation Trails & Event Generation
	ERC20 Idiosyncrasies Handling
	Frontend-Contract Integration
	Deployment Consistency
	Holistic Risk Management
Additional Recommendations	Avoiding Use of Variadic Byte Array
	Using Fixed Compiler Version
	Making Visibility Level Explicit
	Making Type Inference Explicit
	Adhering To Function Declaration Strictly
	Following Other Best Practices

additionally build a PoC to demonstrate the possibility of exploitation. The concrete list of check items is shown in Table 1.3.

In particular, we perform the audit according to the following procedure:

- Basic Coding Bugs: We first statically analyze given smart contracts with our proprietary static code analyzer for known coding bugs, and then manually verify (reject or confirm) all the issues found by our tool.
- Semantic Consistency Checks: We then manually check the logic of implemented smart contracts and compare with the description in the white paper.
- Advanced DeFi Scrutiny: We further review business logics, examine system operations, and place DeFi-related aspects under scrutiny to uncover possible pitfalls and/or bugs.
- Additional Recommendations: We also provide additional suggestions regarding the coding and development of smart contracts from the perspective of proven programming practices.

To better describe each issue we identified, we categorize the findings with Common Weakness Enumeration (CWE-699) [5], which is a community-developed list of software weakness types to better delineate and organize weaknesses around concepts frequently encountered in software development. Though some categories used in CWE-699 may not be relevant in smart contracts, we use the CWE categories in Table 1.4 to classify our findings. Moreover, in case there is an issue that may affect an active protocol that has been deployed, the public version of this report may omit such issue, but will be amended with full details right after the affected protocol is upgraded with respective fixes.

1.4 Disclaimer

Note that this security audit is not designed to replace functional tests required before any software release, and does not give any warranties on finding all possible security issues of the given smart contract(s) or blockchain software, i.e., the evaluation result does not guarantee the nonexistence of any further findings of security issues. As one audit-based assessment cannot be considered comprehensive, we always recommend proceeding with several independent audits and a public bug bounty program to ensure the security of smart contract(s). Last but not least, this security audit should not be used as investment advice.

Table 1.4: Common Weakness Enumeration (CWE) Classifications Used in This Audit

Category	Summary
Configuration	Weaknesses in this category are typically introduced during the configuration of the software.
Data Processing Issues	Weaknesses in this category are typically found in functionality that processes data.
Numeric Errors	Weaknesses in this category are related to improper calculation or conversion of numbers.
Security Features	Weaknesses in this category are concerned with topics like authentication, access control, confidentiality, cryptography, and privilege management. (Software security is not security software.)
Time and State	Weaknesses in this category are related to the improper management of time and state in an environment that supports simultaneous or near-simultaneous computation by multiple systems, processes, or threads.
Error Conditions, Return Values, Status Codes	Weaknesses in this category include weaknesses that occur if a function does not generate the correct return/status code, or if the application does not handle all possible return/status codes that could be generated by a function.
Resource Management	Weaknesses in this category are related to improper management of system resources.
Behavioral Issues	Weaknesses in this category are related to unexpected behaviors from code that an application uses.
Business Logic	Weaknesses in this category identify some of the underlying problems that commonly allow attackers to manipulate the business logic of an application. Errors in business logic can be devastating to an entire application.
Initialization and Cleanup	Weaknesses in this category occur in behaviors that are used for initialization and breakdown.
Arguments and Parameters	Weaknesses in this category are related to improper use of arguments or parameters within function calls.
Expression Issues	Weaknesses in this category are related to incorrectly written expressions within code.
Coding Practices	Weaknesses in this category are related to coding practices that are deemed unsafe and increase the chances that an exploitable vulnerability will be present in the application. They may not directly introduce a vulnerability, but indicate the product has not been carefully developed or maintained.

2 | Findings

2.1 Summary

Here is a summary of our findings after analyzing the implementation of the `Deperp Governance` protocol. During the first phase of our audit, we study the smart contract source code and run our in-house static code analyzer through the codebase. The purpose here is to statically identify known coding bugs, and then manually verify (reject or confirm) issues reported by our tool. We further manually review business logic, examine system operations, and place DeFi-related aspects under scrutiny to uncover possible pitfalls and/or bugs.

Severity	# of Findings	
Critical	0	
High	0	
Medium	0	
Low	1	■
Informational	1	■
Total	2	

We have so far identified a list of potential issues: some of them involve subtle corner cases that might not be previously thought of, while others refer to unusual interactions among multiple contracts. For each uncovered issue, we have therefore developed test cases for reasoning, reproduction, and/or verification. After further analysis and internal discussion, we determined a few issues of varying severities need to be brought up and paid more attention to, which are categorized in the above table. More information can be found in the next subsection, and the detailed discussions of each of them are in Section 3.

2.2 Key Findings

Overall, these smart contracts are well-designed and engineered, though the implementation can be improved by resolving the identified issues (shown in Table 2.1), including 1 low-severity vulnerability and 1 informational recommendation.

Table 2.1: Key Deperp Governance Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Low	Improved Proposal Execution Logic in GovernorBravoDelegate	Business Logic	Confirmed
PVE-002	Informational	Redundant Code/State/Event Removal	Coding Practices	Resolved

Beside the identified issues, we emphasize that for any user-facing applications and services, it is always important to develop necessary risk-control mechanisms and make contingency plans, which may need to be exercised before the mainnet deployment. The risk-control mechanisms should kick in at the very moment when the contracts are being deployed on mainnet. Please refer to Section 3 for details.

3 Detailed Results

3.1 Improved Proposal Execution Logic in GovernorBravoDelegate

- ID: PVE-001
- Severity: Low
- Likelihood: Low
- Impact: Low
- Target: `GovernorBravoDelegate`
- Category: Business Logic [4]
- CWE subcategory: CWE-841 [2]

Description

The `Deperp Governance` protocol is based on the popular `Compound` governance subsystem. In the process of examining the lifecycle of an active proposal, we notice the proposal execution logic may be improved.

To elaborate, we show below the code snippet of the `execute()` routine. As the name indicates, it is designed to execute a queued proposal if its `ETA` has passed. However, we notice that a proposal's low-level execution call may accompany with the associated transfer of native coin, i.e., `proposal.values[i]` (line 361). And the use of `payable` modifier (line 351) in this `execute()` routine serves the same purpose. With that, we can relay the transfer of native coin from the calling user to the `Timelock` contract for the intended proposal execution.

```
351     function execute(uint proposalId) external payable {
352         require(
353             state(proposalId) == ProposalState.Queued,
354             "GovernorBravo::execute: proposal can only be executed if it is queued"
355         );
356         Proposal storage proposal = proposals[proposalId];
357         proposal.executed = true;
358         for (uint i = 0; i < proposal.targets.length; i++) {
359             timelock.executeTransaction(
360                 proposal.targets[i],
361                 proposal.values[i],
362                 proposal.signatures[i],
```

```
363                 proposal.calldatas[i],
364                 proposal.eta
365             );
366         }
367         emit ProposalExecuted(proposalId);
368     }
```

Listing 3.1: GovernorBravoDelegate::execute()

Recommendation Revisit the above `registerVexecuteestingSchedule()` routine to properly pass the transfer of native coins.

Status This issue has been confirmed.

3.2 Redundant State/Code Removal

- ID: PVE-002
- Severity: Informational
- Likelihood: N/A
- Impact: N/A
- Target: `GovernorBravoDelegate`
- Category: Coding Practices [3]
- CWE subcategory: CWE-563 [1]

Description

The `Deperp Governance` protocol makes good use of a number of reference contracts to facilitate its code implementation and organization. For example, the `GovernorBravoDelegate` smart contract has so far imported at least three reference contracts. However, we observe the inclusion of certain unused code or the presence of unnecessary redundancies that can be safely removed.

For example, if we examine closely the `GovernorBravoDelegate` contract and specifically the `_acceptAdmin()` function, it contains a redundant validation on `msg.sender != address(0)`. As this validation will always yield true, we can safely remove it.

```
799     function _acceptAdmin() external {
800         // Check caller is pendingAdmin and pendingAdmin != address(0)
801         require(
802             msg.sender == pendingAdmin && msg.sender != address(0),
803             "GovernorBravo::_acceptAdmin: pending admin only"
804         );
805
806         // Save current values for inclusion in log
807         address oldAdmin = admin;
808         address oldPendingAdmin = pendingAdmin;
809
810         // Store admin with value pendingAdmin
811         admin = pendingAdmin;
```

```
812
813         // Clear the pending value
814         pendingAdmin = address(0);
815
816         emit NewAdmin(oldAdmin, admin);
817         emit NewPendingAdmin(oldPendingAdmin, pendingAdmin);
818     }
```

Listing 3.2: GovernorBravoDelegate::_acceptAdmin()

Recommendation Consider the removal of the redundant state (or code) with a simplified, consistent implementation.

Status This issue has been resolved by following the above suggestion.

4 Conclusion

In this audit, we have analyzed the governance subsystem of the Deperp protocol, which is a decentralized derivatives exchange where participants can trade perpetual contracts on 60+ assets. The protocol combine financial innovation with the power of community and gamification mechanics to encourage active participation and ecosystem development. The current code base is well structured and neatly organized. Those identified issues are promptly confirmed and addressed.

Moreover, we need to emphasize that Solidity-based smart contracts as a whole are still in an early, but exciting stage of development. To improve this report, we greatly appreciate any constructive feedbacks or suggestions, on our methodology, audit findings, or potential gaps in scope/coverage.

References

[1] MITRE. CWE-563: Assignment to Variable without Use. https://cwe.mitre.org/data/definitions/563.html.

[2] MITRE. CWE-841: Improper Enforcement of Behavioral Workflow. https://cwe.mitre.org/data/definitions/841.html.

[3] MITRE. CWE CATEGORY: Bad Coding Practices. https://cwe.mitre.org/data/definitions/1006.html.

[4] MITRE. CWE CATEGORY: Business Logic Errors. https://cwe.mitre.org/data/definitions/840.html.

[5] MITRE. CWE VIEW: Development Concepts. https://cwe.mitre.org/data/definitions/699.html.

[6] OWASP. Risk Rating Methodology. https://www.owasp.org/index.php/OWASP_Risk_Rating_Methodology.

[7] PeckShield. PeckShield Inc. https://www.peckshield.com.