



SMART CONTRACT AUDIT REPORT

for

XVSVault in Venus



Prepared By: Xiaomi Huang

PeckShield
March 22, 2023

Document Properties

Client	Venus
Title	Smart Contract Audit Report
Target	XVSVault
Version	1.0
Author	Xiaotao Wu
Auditors	Xiaotao Wu, Xuxian Jiang
Reviewed by	Xiaomi Huang
Approved by	Xuxian Jiang
Classification	Public

Version Info

Version	Date	Author(s)	Description
1.0	March 22, 2023	Xiaotao Wu	Final Release
1.0-rc	March 16, 2023	Xiaotao Wu	Release Candidate #1

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

Contents

1	Introduction	4
1.1	About XVSVault	4
1.2	About PeckShield	5
1.3	Methodology	5
1.4	Disclaimer	7
2	Findings	9
2.1	Summary	9
2.2	Key Findings	10
3	Detailed Results	11
3.1	Improper Pending Reward Calculation in XVSVault::deposit()/claim()	11
4	Conclusion	13
	References	14

1 | Introduction

Given the opportunity to review the design document and related smart contract source code of the Venus XVSVault revision, 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 can be further improved due to the presence of several issues related to either security or performance. This document outlines our audit results.

1.1 About XVSVault

The Venus protocol is designed to enable a complete algorithmic money market protocol on Binance Smart Chain (BSC). Venus enables users to utilize their cryptocurrencies by supplying collateral to the protocol that may be borrowed by pledging over-collateralized cryptocurrencies. The audited Venus XVSVault implements an upgrade for the old one to stop the xvs reward distribution for the pending withdrawal pool tokens. The basic information of the audited protocol is as follows:

Table 1.1: Basic Information of The XVSVault

Item	Description
Name	Venus
Website	https://venus.io/
Type	EVM Smart Contract
Platform	Solidity
Audit Method	Whitebox
Latest Audit Report	March 22, 2023

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

- <https://github.com/VenusProtocol/venus-protocol/pull/184> (2d8bd0c)

- <https://github.com/VenusProtocol/venus-protocol/pull/208> (28c3922)
- <https://github.com/VenusProtocol/venus-protocol/pull/212> (ff5ddb5)

1.2 About PeckShield

PeckShield Inc. [5] 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

Impact	High	Critical	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low
		High	Medium	Low
		Likelihood		

1.3 Methodology

To standardize the evaluation, we define the following terminology based on OWASP Risk Rating Methodology [4]:

- 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 list of check 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

Table 1.3: The Full List of Check Items

Category	Check Item
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

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 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) [3], 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.

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 Logics	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 design and implementation of the `venus xVSVault` revision. 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 logics, 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	1	
Low	0	
Informational	0	
Total	1	

We have so far identified a potential issue for improvement: the pending rewards calculation for a user may not correct if this user requests withdrawal before the upgrade of the `xVSVault` contract. More information can be found in the next subsection, and its detailed discussions can be found in [Section 3](#).

2.2 Key Findings

Overall, the smart contract is well-designed and engineered, though the implementation can be improved by resolving the identified issue (shown in Table 2.1), including 1 medium-severity vulnerability.

Table 2.1: Key XVSVault Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Medium	Improper Pending Reward Calculation in XVSVault::deposit()/claim()	Business Logic	Fixed

Besides recommending specific countermeasures to mitigate these issues, we also emphasize that 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 need to kick in at the very moment when the contracts are being deployed in mainnet. Please refer to Section 3 for details.



3 | Detailed Results

3.1 Improper Pending Reward Calculation in XVSVault::deposit()/claim()

- ID: PVE-001
- Severity: Medium
- Likelihood: High
- Impact: Low
- Target: xsvVault
- Category: Business Logic [2]
- CWE subcategory: CWE-841 [1]

Description

The xsvVault contract allows users to deposit the supported assets to the pool to earn rewards. While examining the deposit() routine of the xsvVault contract, we notice the current implementation logic is not correct.

To elaborate, we show below the related code snippet. It comes to our attention that the pending rewards calculation for a user may not be correct (line 176). Specifically, if the user.pendingWithdrawals is requested before the contract upgrade, then the user.pendingWithdrawals should not be subtracted from the user.amount when calculating the pending rewards. Moreover, the current pending rewards calculation may revert if `user.amount.sub(user.pendingWithdrawals).mul(pool.accRewardPerShare).div(1e12) < user.rewardDebt`

```
164  /**
165   * @notice Deposit XSVVault for XVS allocation
166   * @param _rewardToken The Reward Token Address
167   * @param _pid The Pool Index
168   * @param _amount The amount to deposit to vault
169   */
170  function deposit(address _rewardToken, uint256 _pid, uint256 _amount) external
171      nonReentrant {
172      _ensureValidPool(_rewardToken, _pid);
173      PoolInfo storage pool = poolInfos[_rewardToken][_pid];
174      UserInfo storage user = userInfos[_rewardToken][_pid][msg.sender];
```

```
174     _updatePool(_rewardToken, _pid);
175     if (user.amount > 0) {
176         uint256 pending = user.amount.sub(user.pendingWithdrawals).mul(pool.
            accRewardPerShare).div(1e12).sub(
177             user.rewardDebt
178         );
179         IXVSStore(xvsStore).safeRewardTransfer(_rewardToken, msg.sender, pending);
180         emit Claim(msg.sender, _rewardToken, _pid, pending);
181     }
182     pool.token.safeTransferFrom(address(msg.sender), address(this), _amount);
183     user.amount = user.amount.add(_amount);
184     user.rewardDebt = user.amount.sub(user.pendingWithdrawals).mul(pool.
        accRewardPerShare).div(1e12);
185
186     // Update Delegate Amount
187     if (address(pool.token) == address(xvsAddress)) {
188         _moveDelegates(address(0), delegates[msg.sender], uint96(_amount));
189     }
190
191     emit Deposit(msg.sender, _rewardToken, _pid, _amount);
192 }
```

Listing 3.1: XSVVault::deposit()

Note the same issue also exists in the `claim()` routine.

Recommendation Revisit the above mentioned functions to correctly calculate the pending rewards for users.

Status The issue has been fixed by the following pull request: 233.

4 | Conclusion

In this audit, we have analyzed the `Venus xVSVault` design and implementation. The audited `Venus xVSVault` implements an upgrade for the old one to stop the `xvs` reward distribution for the pending withdrawal pool tokens. The current code base is well structured and neatly organized. Those identified issues are promptly confirmed and addressed.

Meanwhile, 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-841: Improper Enforcement of Behavioral Workflow. <https://cwe.mitre.org/data/definitions/841.html>.
- [2] MITRE. CWE CATEGORY: Business Logic Errors. <https://cwe.mitre.org/data/definitions/840.html>.
- [3] MITRE. CWE VIEW: Development Concepts. <https://cwe.mitre.org/data/definitions/699.html>.
- [4] OWASP. Risk Rating Methodology. https://www.owasp.org/index.php/OWASP_Risk_Rating_Methodology.
- [5] PeckShield. PeckShield Inc. <https://www.peckshield.com>.