



# SMART CONTRACT AUDIT REPORT

for

## YAM FINANCE



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# 1 | Introduction

Given the opportunity to review the **YAMv2** smart contract source code, we in the report outline 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 the implementation is of high-quality and in accordance with the purpose despite the presence of several (minor) issues. This document outlines our audit results.

## 1.1 About YAMv2

Migrated from YAMv1, YAMv2 has two main components: YAMv2 ERC-20 token and YAMv2Migration. The first component is in essence a standard ERC-20 token with no rebases to serve as placeholder and the second component performs the actual migration that allows all YAMv1 holders to burn their YAMv1 tokens in order to mint their share of YAMv2 tokens. Note that the number of YAMv2 tokens received after migration will be based upon each holder's YAMv1 `yamBalances`, which remains constant regardless of rebases.

The basic information of YAMv2 is as follows:

Table 1.1: Basic Information of YAMv2

| Item                | Description   |
|---------------------|---|
| Issuer              | Yam Finance   |
| Website             | <a href="https://yam.finance/">https://yam.finance/</a> |
| Type                | Ethereum Smart Contract                                 |
| Platform            | Solidity  |
| Audit Method        | Whitebox  |
| Latest Audit Report | August 19, 2020   |

In the following, we show the repository of reviewed code and the commit hash value used in this

audit:

- <https://github.com/yam-finance/yam-migration.git> (5a79aec)

## 1.2 About PeckShield

PeckShield Inc. [15] 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](mailto: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 [10]:

- 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) [9], 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 audit does not give any warranties on finding all possible security issues of the given smart contract(s), 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 an investment advice.



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

| Category   | Summary   |
|--|---|
| <b>Configuration</b>                                 | Weaknesses in this category are typically introduced during the configuration of the software.  |
| <b>Data Processing Issues</b>                        | Weaknesses in this category are typically found in functionality that processes data.   |
| <b>Numeric Errors</b>                                | Weaknesses in this category are related to improper calculation or conversion of numbers.   |
| <b>Security Features</b>                             | Weaknesses in this category are concerned with topics like authentication, access control, confidentiality, cryptography, and privilege management. (Software security is not security software.)   |
| <b>Time and State</b>                                | 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.  |
| <b>Error Conditions, Return Values, Status Codes</b> | 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.   |
| <b>Resource Management</b>                           | Weaknesses in this category are related to improper management of system resources.   |
| <b>Behavioral Issues</b>                             | Weaknesses in this category are related to unexpected behaviors from code that an application uses.   |
| <b>Business Logics</b>                               | 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.  |
| <b>Initialization and Cleanup</b>                    | Weaknesses in this category occur in behaviors that are used for initialization and breakdown.  |
| <b>Arguments and Parameters</b>                      | Weaknesses in this category are related to improper use of arguments or parameters within function calls.   |
| <b>Expression Issues</b>                             | Weaknesses in this category are related to incorrectly written expressions within code.   |
| <b>Coding Practices</b>                              | 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 YAMv2 implementation. During the first phase of our audit, we studied the smart contract source code and ran 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        | 0             |     |
| Low           | 2             | ■ ■ |
| Informational | 1             | ■   |
| Total         | 3             |     |

We have so far identified a list of potential issues. For each uncovered issue, we have therefore developed test cases for reasoning, reproduction, and/or verification. After further analysis and internal discussion, we determined three of them 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 2 low-severity vulnerabilities and 1 informational recommendation.

Table 2.1: Key YAMv2 Audit Findings

| ID      | Severity      | Title   | Category          | Status    |
|---------|---------------|---|-------------------|-----------|
| PVE-001 | Informational | <a href="#">Unused Library Removal</a>                    | Coding Practices  | Fixed     |
| PVE-002 | Low           | <a href="#">No Migration Before Token Initialization</a>  | Security Features | Fixed     |
| PVE-003 | Low           | <a href="#">(Minor) Non-Compliance of ERC-20 Standard</a> | Coding Practices  | Confirmed |

Please refer to Section 3 for details.



## 3 | Detailed Results

### 3.1 Unused Library Removal

- ID: PVE-001
- Severity: Informational
- Likelihood: N/A
- Impact: N/A
- Target: YAMv2
- Category: Coding Practices [8]
- CWE subcategory: CWE-561 [6]

#### Description

YAMv2 makes good use of a few library functions, such as `Context`, `SafeERC20`, `IERC20`, `SafeMath`, `Address`, and `Ownable`, to facilitate its various calculations and computations. For example, the YAMv2 smart contract imports at least four libraries, i.e., `Context`, `IERC20`, `SafeMath` and `Address`.

If we examine the `Address` library, it provides two handy routines: `isContract()` and `sendValue()`. The first one determines whether the provided account is a contract or not while the second one provides a replacement of Solidity's `transfer()` by forwarding all available gas and reverting on errors (due to introduced gas cost change of certain opcodes in EIP1884 [2]). However, both these two routines are not used anymore in current code base. Therefore, the `Address` library can be safely removed.

```
3 pragma solidity ^0.6.0;
4
5 import "./lib/Context.sol";
6 import "./lib/IERC20.sol";
7 import "./lib/SafeMath.sol";
8 import "./lib/Address.sol";
9
10
11
12 /**
13  * @title YAMv2 Token
14  * @dev YAMv2 Mintable Token with migration from legacy contract. Used to signal
15  *      for protocol changes in v3.
```

```

16  */
17  contract YAMv2 is Context, IERC20 {
18      using SafeMath for uint256;
19      using Address for address;
20
21      ...
22
23  }

```

Listing 3.1: YAMv2.sol

**Recommendation** Remove the `Address` library in current code base and delete their reference in YAMv2 (line 8) as well.

**Result** This issue has been addressed by removing the unused `Address` library and reflected in this commit: [509db8e8b82edc0bbaf2e68fd7c35acf44fc9ec1](#).

## 3.2 No Migration Before Token Initialization

- ID: PVE-002
- Severity: Low
- Likelihood: Low
- Impact: N/A
- Target: YAMv2Migration.sol
- Category: Security Features [7]
- CWE subcategory: CWE-284 [4]

### Description

The migration logic proceeds by first determining the calling user's balance in YAMv1, next burning the balance (by essentially transferring the balance to an address no one has access to the corresponding private key), and then minting corresponding YAMv2 amount to the user. To properly kick-off the migration process, the smart contract ensures that the migration process takes place only during the specified migration period: `[startTime, startTime + migrationDuration)`. Both `startTime` and `migrationDuration` are constants hard-coded in the contract implementation.

Our analysis shows that there is one more requirement that needs to be satisfied before actually starting the migration process, i.e., the YAMv2 token address has been properly initialized. A non-initialized YAMv2 address (default `address(0)`) could result in the attempt to burn YAMv1 tokens. Fortunately, the `address(0).mint()` call would revert the transaction and hence no loss will be caused.

```

55  /**
56   * @dev Migrate a users' entire balance
57   *
58   * One way function. YAMv1 tokens are BURNED. YAMv2 tokens are minted.
59   */
60  function migrate() public virtual {

```



**Recommendation** Ensure that the migration process does not take place until the `YAMv2` token address has been properly initialized (in addition to being within the specified 3-day time window of migration). And we can further (slightly) simplify the logic as follows:

```

55  /**
56   * @dev Migrate a users' entire balance
57   *
58   * One way function. YAMv1 tokens are BURNED. YAMv2 tokens are minted.
59   */
60  function migrate() public virtual {
61      require(token_initialized, "YAMv2 not set yet");
62      require(block.timestamp >= startTime, "!started");
63      require(block.timestamp < startTime + migrationDuration, "migration ended");
64
65      // current scalingFactor
66      uint256 scalingFactor = YAM(yam).yamsScalingFactor();
67
68      // gets the yamValue for a user.
69      uint256 yamValue = YAM(yam).balanceOfUnderlying(_msgSender());
70
71      // gets transferFrom amount by multiplying by scaling factor / 10**24
72      // equivalent to balanceOf, but we need underlyingAmount later
73      uint256 transferAmount = yamValue.mul(scalingFactor).div(internalDecimals);
74      require(transferAmount > 0, "No yams");
75
76
77      // BURN YAM - UNRECOVERABLE.
78      SafeERC20.safeTransferFrom(
79          IERC20(yam),
80          _msgSender(),
81          address(0x0000000000000000000000000000000000000000000000000000000000000000dEaD),
82          transferAmount
83      );
84
85      // mint new YAMv2, using yamValue (1e24 decimal token, to match internalDecimals
86      )
87      YAMv2(yamV2).mint(_msgSender(), yamValue);
88  }

```

Listing 3.3: YAMv2Migration.sol (revised)

**Result** This issue has been addressed by adding the suggested requirement and fixed in this commit: [e41a9fc0be4fb994ab36c20a5793e26b21aafd33](#).

### 3.3 (Minor) Non-Compliance of ERC-20 Standard

- ID: PVE-003
- Severity: Low
- Likelihood: Low
- Impact: Low
- Target: YAMv2
- Category: Coding Practices [8]
- CWE subcategory: CWE-547 [5]

#### Description

ERC-20 is a community-driven standard that specifies basic functionality to transfer tokens, as well as allow tokens to be approved so they can be later spent by another on-chain third party. The defined interfaces include widely used `transfer()`, `transferFrom()`, `approve()` etc.

We note the `transfer()` implementation slightly deviates from the ERC-20 standard. Specifically, the standard explicitly makes it clear that *"Transfers of 0 values MUST be treated as normal transfers and fire the Transfer event"* [3]. But there is no restriction imposed on the recipient!

The current implementation, however, shows that `transfer()` to the recipient `address(0)` is explicitly prohibited (see the related code snippet below - line 201). This is an additional requirement beyond the standard.

```

185  /**
186   * @dev Moves tokens 'amount' from 'sender' to 'recipient'.
187   *
188   * This is internal function is equivalent to {transfer}, and can be used to
189   * e.g. implement automatic token fees, slashing mechanisms, etc.
190   *
191   * Emits a {Transfer} event.
192   *
193   * Requirements:
194   *
195   * - 'sender' cannot be the zero address.
196   * - 'recipient' cannot be the zero address.
197   * - 'sender' must have a balance of at least 'amount'.
198   */
199  function _transfer(address sender, address recipient, uint256 amount) internal
    virtual {
200      require(sender != address(0), "ERC20: transfer from the zero address");
201      require(recipient != address(0), "ERC20: transfer to the zero address");
202
203      _balances[sender] = _balances[sender].sub(amount, "ERC20: transfer amount
    exceeds balance");
204      _balances[recipient] = _balances[recipient].add(amount);
205      emit Transfer(sender, recipient, amount);
206  }

```

Listing 3.4: YAMv2.sol



In the meantime, we notice that it is also a common practice in blocking the token transfers to `address(0)` as it prevents certain insufficiently tested software (that may accidentally provide an empty argument as recipient) from sending the funds into the void.

**Recommendation** This is really optional and the above ERC-20 deviation is considered minor. Our suggestion is to be compliant with the ERC-20 standard if at all possible.

**Result** The YAMv2 smart contract is heavily based on the default OpenZeppelin implementation of ERC-20 standard: <https://github.com/OpenZeppelin/openzeppelin-contracts/blob/master/contracts/token/ERC20/ERC20.sol>. We both agree that we can just leave it as is.

### 3.4 Other Suggestions

Due to the fact that compiler upgrades might bring unexpected compatibility or inter-version inconsistencies, it is always suggested to use fixed compiler versions whenever possible. As an example, we highly encourage to explicitly indicate the Solidity compiler version, e.g., `pragma solidity 0.6.0;` instead of `pragma solidity >=0.6.0;`.

Moreover, 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.



## 4 | Conclusion

In this audit, we thoroughly analyzed the YAMv2 design and implementation. Overall, YAM presents a unique offering in current DeFi ecosystem and we are impressed by the design and implementation. The current code base is well organized and those identified issues are promptly confirmed and fixed.

Meanwhile, we need to emphasize that 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.

**Note:** We received full payment from Yam Finance for our security audit service. In the following, we disclose the related transaction hash that completed the payment:

<https://etherscan.io/tx/0xf1dcb609401efd8e6ed4e74908f9fb301d4a052656f98736ec7cab0f30ed6787>.



## 5 | Appendix

### 5.1 Basic Coding Bugs

---

#### 5.1.1 Constructor Mismatch

- Description: Whether the contract name and its constructor are not identical to each other.
- Result: Not found
- Severity: Critical

#### 5.1.2 Ownership Takeover

- Description: Whether the set owner function is not protected.
- Result: Not found
- Severity: Critical

#### 5.1.3 Redundant Fallback Function

- Description: Whether the contract has a redundant fallback function.
- Result: Not found
- Severity: Critical

#### 5.1.4 Overflows & Underflows

- Description: Whether the contract has general overflow or underflow vulnerabilities [11, 12, 13, 14, 16].
- Result: Not found
- Severity: Critical

### 5.1.5 Reentrancy

- Description: Reentrancy [17] is an issue when code can call back into your contract and change state, such as withdrawing ETHs.
- Result: Not found
- Severity: Critical

### 5.1.6 Money-Giving Bug

- Description: Whether the contract returns funds to an arbitrary address.
- Result: Not found
- Severity: High

### 5.1.7 Blackhole

- Description: Whether the contract locks ETH indefinitely: merely in without out.
- Result: Not found
- Severity: High

### 5.1.8 Unauthorized Self-Destruct

- Description: Whether the contract can be killed by any arbitrary address.
- Result: Not found
- Severity: Medium

### 5.1.9 Revert DoS

- Description: Whether the contract is vulnerable to DoS attack because of unexpected revert.
- Result: Not found
- Severity: Medium

#### 5.1.10 Unchecked External Call

- Description: Whether the contract has any external call without checking the return value.
- Result: Not found
- Severity: Medium

#### 5.1.11 Gasless Send

- Description: Whether the contract is vulnerable to gasless send.
- Result: Not found
- Severity: Medium

#### 5.1.12 Send Instead Of Transfer

- Description: Whether the contract uses send instead of transfer.
- Result: Not found
- Severity: Medium

#### 5.1.13 Costly Loop

- Description: Whether the contract has any costly loop which may lead to Out-Of-Gas exception.
- Result: Not found
- Severity: Medium

#### 5.1.14 (Unsafe) Use Of Untrusted Libraries

- Description: Whether the contract use any suspicious libraries.
- Result: Not found
- Severity: Medium

### 5.1.15 (Unsafe) Use Of Predictable Variables

- Description: Whether the contract contains any randomness variable, but its value can be predicated.
- Result: Not found
- Severity: Medium

### 5.1.16 Transaction Ordering Dependence

- Description: Whether the final state of the contract depends on the order of the transactions.
- Result: Not found
- Severity: Medium

### 5.1.17 Deprecated Uses

- Description: Whether the contract use the deprecated `tx.origin` to perform the authorization.
- Result: Not found
- Severity: Medium

## 5.2 Semantic Consistency Checks

---

- Description: Whether the semantic of the white paper is different from the implementation of the contract.
- Result: Not found
- Severity: Critical

## 5.3 Additional Recommendations

---

### 5.3.1 Avoid Use of Variadic Byte Array

- Description: Use fixed-size byte array is better than that of `byte[]`, as the latter is a waste of space.
- Result: Not found
- Severity: Low

### 5.3.2 Make Visibility Level Explicit

- Description: Assign explicit visibility specifiers for functions and state variables.
- Result: Not found
- Severity: Low

### 5.3.3 Make Type Inference Explicit

- Description: Do not use keyword `var` to specify the type, i.e., it asks the compiler to deduce the type, which is not safe especially in a loop.
- Result: Not found
- Severity: Low

### 5.3.4 Adhere To Function Declaration Strictly

- Description: Solidity compiler (version 0.4.23) enforces strict ABI length checks for return data from `calls()` [1], which may break the the execution if the function implementation does NOT follow its declaration (e.g., no return in implementing `transfer()` of ERC20 tokens).
- Result: Not found
- Severity: Low



## References

- [1] axic. Enforcing ABI length checks for return data from calls can be breaking. <https://github.com/ethereum/solidity/issues/4116>.
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