

# **Adrenaline A.I. Token Contract Audit Report**

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# 1. Introduction

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This is the Adrenaline AI Token Contract Audit report with the extensive code coverage and vulnerabilities .

## 1.1 Safe Audits Of Internally Written Code

- A. Audit is done only when the team delivered the code as fit for purpose. This is known as a 'Chinese Wall' in some circles, and we followed these tight security procedures internally; No one had any access, even read-only access to the repository until the audit began.
- B. These constraints might seem extreme, but we are very focused on maintaining safety for all clients, and caution is warranted for any software that will be asked to secure customer funds.

## 1.3 Long term goals for the codebase

- A. ERC20 contracts are the standard to implement – the API is short, and the general functionality encapsulated is minimal. However, in the last year a number of small-scale vulnerabilities and 'gotchas' have been published or discovered.
- B. It can be said that overall the codebase is excellent, well engineered, and succeeds in these goals.

## 1.3 Methodology

- A. Code was double audited, first working through our internal list of known attacks on smart contracts and ERC20 contracts and verified that the contracts were not vulnerable to these attacks. Attacks considered include recursive calls, over and underflow errors, replay attacks, reordering attacks, the so-called "double cross" and "single cross" attacks and Solar storm style process injection attacks.
- B. It was then re-audited the files line by line, usually bottom up to maintain as little 'flow' that might cause complacency while reading as possible and worked to read and audit each small block of code carefully. Nevertheless we may have missed one or more small or large problems; this is why we publish the smart contract code for community review.

## 2. Files Audited

The source code of the token have been published at

<https://etherscan.io/address/0x03e1ae8650dd25b9e4666e7a5b1ea897e284292d#code>

The contract source code based on which the audit is performed is available at :

<https://github.com/AraiTeam/TokenInformation/blob/master/ARAI%20smart%20contract.sol>

**Commit: 9b70b1bc87960d19bbea196fdd5bf0409c28f98d**

Audited contract name: **ARAI**

## 3. Disclaimer

- A. The audit makes no statements or warranties about the utility of the code, suitability of the business model, regulatory regime for the business model, or any other statements about the fitness of the contracts to purpose, or their full bugfree status.
- B. The audit documentation is to evaluate the safety of the code.

## 4. Executive Summary

Overall this is a super ambitious ERC20 contract that is well conceived and well executed. This contract is a good model for a modern ERC20 contract with various protections built in; as of July 2019, it is *best in class* for features delivered.

The contract provides for the following interesting features and use cases:

1. A 'createToken' function to mint the tokens and increase circulating SOMA token supply.
2. A function to change the owner of the contract.
3. Ability to freeze and unfreeze the transfer and essentially locking or unlocking the token contract.
4. A function to freeze any particular account and blocking them from executing any transfer on the contract.

5. A function to refund the accidentally sent non-SOMA token back to the owner.

In summary, We can consider this contract safe for use and built with the long term in mind.

## 5. Vulnerability Discussions :

The initial internal audit turned up one critical vulnerabilities and one moderate one. This audit aim to provide the amended code to mitigate these vulnerabilities.

### 5.1 Critical

A number of common critical vulnerabilities **do not** appear in this repository.

### 5.2 Moderate

A number of common minor vulnerabilities **do not** appear in this repository.

### 5.3 Minor

Found one “Minor” bug, See discussion on the Owner’s Rights during and after the initial token sale period. In particular, claim tokens mechanics are worth paying attention to. (see 5.4)

Overall the safety of these contracts will increase when owner is set to a multisignature wallet.

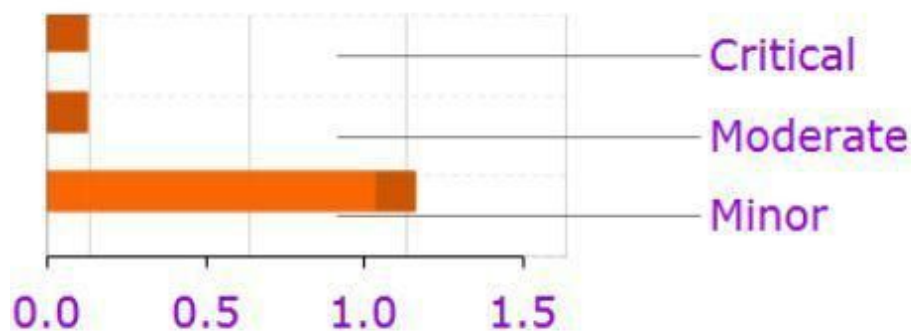


Figure 1:Vulnerability Count

## 5.4 Minor: Owner's Rights

The owner has two sets of rights that are unusual in comparison to other ERC20 contracts: these revolve around the Ownership change mechanics and the claim Tokens method.

### 5.4.1 A great tackle to approve Ownership Changes

- A. It is great to have an approval mechanic for ownership change, but it is worth talking about the security trade-offs. In the very unlikely case of racing an attacker who has compromised the owner key but not changed the owner yet, requiring approval from a new owner address may slow down seizure of the contract from the attacker. It is hard to imagine an attacker that is sophisticated enough to engage as the owner after key compromise but not sophisticated enough to change the owner at the first chance, though.
- B. In exchange for this very slight reduction in security, you get what seems to me to be a big benefit - nobody, including an attacker with the owner key – can lock the contract by changing the owner to an invalid address. You are always guaranteed that the new owner can sign transactions that are function calls. I think this is a good trade-off, and recommend this idea in general.

### 5.4.2 Claim Tokens:

Note the initial sale does not have any situation in which tokens or ETH may be claimable. A full discussion of these mechanisms is beyond the scope of the audit, but readers are encouraged To engage to implement that.

#### Summary (Suggestive but not Mandatory):

1. Multisig-wallet address for owner.
2. Claim Token functionality will be a value add depending on business situations.

## 6. Line by Line Comments

Included below are the line by line comments and notes as part of the audit process.

## Line 1: Solidity Version

The version of Solidity used is 0.5.10. It is a great way to tackle old vulnerabilities which present in old versions. In the below all known bugs are mentioned which are tackled classically by using the latest stable version of solidity. In other terms we can say this contract is free from the below bugs:

```
[
{
  "name": "ZeroFunctionSelector",
    "summary": "It is possible to craft the name of a function such that it is executed instead of the fallback function in very specific circumstances.",

    "description": "If a function has a selector consisting only of zeros, is payable and part of a contract that does not have a fallback function and at most five external functions in total, this function is called instead of the fallback function if Ether is sent to the contract without data.",

  "fixed": "0.4.18",

  "severity": "very low"
},
{
  "name": "DelegateCallReturnValue",
    "summary": "The low-level .delegatecall() does not return the execution outcome, but converts the value returned by the functioned called to a boolean instead.",

    "description": "The return value of the low-level .delegatecall() function is taken from a position in memory, where the call data or the return data resides. This value is interpreted as a boolean and put onto the stack. This means if the called function returns at least 32 zero bytes, .delegatecall() returns false even if the call was successful.",

  "introduced": "0.3.0",

  "fixed": "0.4.15",

  "severity": "low"
},
{
  "name": "EcrecoverMalformedInput",
  "summary": "The ecrecover() builtin can return garbage for malformed input.",

    "description": "The ecrecover precompile does not properly signal failure for malformed input (especially in the 'v' argument) and thus the Solidity function can return data that was previously present in the return area in memory.",

  "fixed": "0.4.14",

  "severity": "medium"
}
```

```

},

{
  "name": "SkipEmptyStringLiteral",
    "summary": "If \"\" is used in a function call, the following function arguments will
    not be correctly passed to the function.",

    "description": "If the empty string literal \"\" is used as an argument in a function call,
    it is skipped by the encoder. This has the effect that the encoding of all arguments
    following this is shifted left by 32 bytes and thus the function call data is corrupted.",

  "fixed": "0.4.12",

  "severity": "low"

},

{
  "name": "ConstantOptimizerSubtraction",
    "summary": "In some situations, the optimizer replaces certain numbers in the code
    with routines that compute different numbers.",

    "description": "The optimizer tries to represent any number in the bytecode by routines
    that compute them with less gas. For some special numbers, an incorrect routine is generated.
    This could allow an attacker to e.g. trick victims about a specific amount of ether, or function
    calls to call different functions (or none at all).",

  "link": "https://blog.ethereum.org/2017/05/03/solidity-optimizer-bug/",

  "fixed": "0.4.11",

  "severity": "low",

  "conditions": {

    "optimizer": true

  }

},

{
  "name": "IdentityPrecompileReturnIgnored",
  "summary": "Failure of the identity precompile was ignored.",

  "description": "Calls to the identity contract, which is used for copying memory, ignored
  its return value. On the public chain, calls to the identity precompile can be made in a way
  that they never fail, but this might be different on private chains.",

  "severity": "low",

  "fixed": "0.4.7"

},

```



```

{
  "name": "OptimizerStateKnowledgeNotResetForJumpdest",
    "summary": "The optimizer did not properly reset its internal state at jump destinations,
    which could lead to data corruption.",

    "description": "The optimizer performs symbolic execution at certain stages. At jump
    destinations, multiple code paths join and thus it has to compute a common state from the
    incoming edges. Computing this common state was simplified to just use the empty state, but
    this implementation was not done properly. This bug can cause data corruption.",

  "severity": "medium",

  "introduced": "0.4.5",

  "fixed": "0.4.6",

  "conditions": {
    "optimizer": true
  }
},

{
  "name": "HighOrderByteCleanStorage",
    "summary": "For short types, the high order bytes were not cleaned properly and
    could overwrite existing data.",

    "description": "Types shorter than 32 bytes are packed together into the same 32 byte
    storage slot, but storage writes always write 32 bytes. For some types, the higher order bytes
    were not cleaned properly, which made it sometimes possible to overwrite a variable in storage
    when writing to another one.",

  "link":

  "https://blog.ethereum.org/2016/11/01/security-alert-solidity-variables-can-overwritten-storage/",

  "severity": "high",

  "introduced": "0.1.6",

  "fixed": "0.4.4"
},

{
  "name": "OptimizerStaleKnowledgeAboutSHA3",

    "summary": "The optimizer did not properly reset its knowledge about SHA3 operations
    resulting in some hashes (also used for storage variable positions) not being calculated
    correctly."

    "description": "The optimizer performs symbolic execution in order to save re-evaluating
    expressions whose value is already known. This knowledge was not properly reset across control flow

```

paths and thus the optimizer sometimes thought that the result of a SHA3 operation is already present on the stack. This could result in data corruption by accessing the wrong storage slot.",

"severity": "medium",

"fixed": "0.4.3",

"conditions": {

"optimizer": true

}

},

{

"name": "**LibrariesNotCallableFromPayableFunctions**",

"summary": "Library functions threw an exception when called from a call that received Ether.",

"description": "Library functions are protected against sending them Ether through a call. Since the DELEGATECALL opcode forwards the information about how much Ether was sent with a call, the library function incorrectly assumed that Ether was sent to the library and threw an exception.",

"severity": "low",

"introduced": "0.4.0",

"fixed": "0.4.2"

},

{

"name": "**SendFailsForZeroEther**",

"summary": "The send function did not provide enough gas to the recipient if no Ether was sent with it.",

"description": "The recipient of an Ether transfer automatically receives a certain amount of gas from the EVM to handle the transfer. In the case of a zero-transfer, this gas is not provided which causes the recipient to throw an exception.",

"severity": "low",

"fixed": "0.4.0"

},

{

"name": "**DynamicAllocationInfiniteLoop**",

"summary": "Dynamic allocation of an empty memory array caused an infinite loop and thus an exception.",

"description": "Memory arrays can be created provided a length. If this length is zero, code was generated that did not terminate and thus consumed all gas.",

"severity": "low",

"fixed": "0.3.6"

},

{

"name": "**OptimizerClearStateOnCodePathJoin**",

"summary": "The optimizer did not properly reset its internal state at jump destinations, which could lead to data corruption.",

"description": "The optimizer performs symbolic execution at certain stages. At jump destinations, multiple code paths join and thus it has to compute a common state from the incoming edges. Computing this common state was not done correctly. This bug can cause data corruption, but it is probably quite hard to use for targeted attacks.",

"severity": "low",

"fixed": "0.3.6",

"conditions": {

"optimizer": true

}

},

{

"name": "**CleanBytesHigherOrderBits**",

"summary": "The higher order bits of short bytesNN types were not cleaned before comparison.",

"description": "Two variables of type bytesNN were considered different if their higher order

bits, which are not part of the actual value, were different. An attacker might use this to reach seemingly unreachable code paths by providing incorrectly formatted input data.",

"severity": "medium/high",

"fixed": "0.3.3"

},

{

"name": "**ArrayAccessCleanHigherOrderBits**",

"summary": "Access to array elements for arrays of types with less than 32 bytes did not correctly clean the higher order bits, causing corruption in other array elements.",

"description": "Multiple elements of an array of values that are shorter than 17 bytes are packed into the same storage slot. Writing to a single element of such an array did not properly clean the higher order bytes and thus could lead to data corruption.",

"severity": "medium/high",

"fixed": "0.3.1"

},

```
{
  "name": "AncientCompiler",
    "summary": "This compiler version is ancient and might contain several
    undocumented or undiscovered bugs.",

    "description": "The list of bugs is only kept for compiler versions starting from 0.3.0, so
    older versions might contain undocumented bugs.",

  "severity": "high",

  "fixed": "0.3.0"
}
]
```

## Line 17: Safemath Contract

Latest zeppelin Safemath Library is used from the open source project named 'OpenZeppelin'.

<https://github.com/OpenZeppelin/openzeppelin-solidity/blob/master/contracts/math/SafeMath.sol>

It is highly appreciable to use SafeMath contract and reuse it. Most of the successful ICO contracts implement the safety using the same.

It helps in the following way:

1. Reusable to all basic 4 operations in the contract.
2. It mitigates **Overflow** and **Underflow** attacks.

## Line 53: Token Contract

ERC 20 standard is implemented as an interface type contract, where the functions are declared but not implemented. It is good approach to make the contract modular and readable. All ERC 20 compatible methods and events are present in the contract.

## Line 99: Checks in Transfer function

This is nice; it protects from many errors and attacks.

**require(\_to != address(0))**-> Can not send to a **empty or null address**.

**(accounts[msg.sender] < \_value)**return false -> great check to mitigate **spending more amount** than existing in the account.

**(\_value > 0 && msg.sender != \_to)**-> Classical checking of positive balance and the sender can not send the same fund to itself, it nicely tackles the **double spending** attack.

## Line 121: Checks in Transfer from function

This is nice; it protects from many errors and attacks.

**require(\_to != address(0))**-> Can not send to a **empty or null address**.

**(accounts[\_from] < \_value)**return false -> Great check to mitigate **spending more amount** than existing in the account.

**(\_value > 0 && \_from != \_to)**-> Classical checking of positive balance and the sender can not send the same fund to itself, it nicely tackles the **double spending** attack.

**(allowances[\_from][msg.sender] < \_value) return false**-> Spender can not send more amount than allocated via approval method.

## Line 189: Max Token Count

The value mentioned is the same as in whitepaper and website. Constant keyword makes it unalterable once the contract is deployed.

## Line 194: Owner declaration

Owner variable is declared as private which is a classic way to restrict the access of the owner variable from public. It mitigates major vulnerability of ownership change

## Line 225, 226, 227: Decimal, Symbol and Name

The fields mentioned are same as mentioned in Whitepaper. Use of 18 Decimal is good as it is the native maximum decimal points that can be achieved.

## Line 278: Create Tokens

It is the main function to generate tokens. It can only be called by the owner which is obvious

best security and necessary.

**(\_value > safeSub (MAX\_TOKEN\_COUNT, tokenCount)) return false**-> This check ensures that during token generation it can not increase the max supply.

### **Line 307: Burn Tokens**

It is the function to maintain demand and supply of tokens. Burning will contribute to lower the total supply and eventually the demand supply relation will be maintained according to business scenario.

**require(accounts[msg.sender] >= \_value); and require (msg.sender == owner);**

-> This check ensures that burning can only be possible by owner with the limit of owner account balance. This is good as the burning function should not be made public to protect the token economy.

### **Line 330: Transfer Ownership**

Would be nice to stop a foot fault / attack by making sure at least that newOwner isn't 0x0. That doesn't stop someone from making up a malicious newOwner but it would stop a fat finger function call.

### **Line 380: Refund Tokens**

The function is implemented nicely, this function implementation is not present on most other Token contracts. But Adrenaline AI really does a nice job by thinking about other tokens. If user mistakenly send any other tokens to this contract address, then that will not be locked in the contract rather refund tokens function can send the tokens back to the user. It proves how Adrenaline AI considers transparency and created most of the functions to mitigate this type of mistakes.

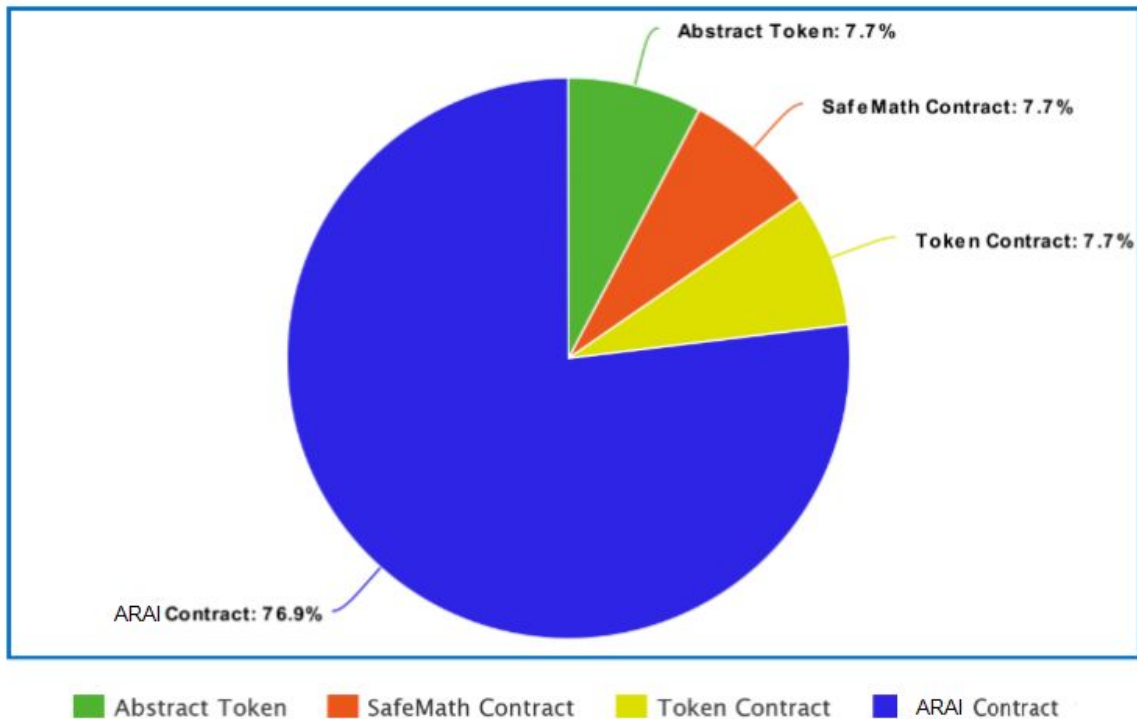


Figure 2: Comment Distribution

## 7. Notes on Some Vulnerabilities

### 7.1 Short Address Attack

The codebase fixes a common vulnerability in ERC20 tokens; some explanation on the vulnerability is included here.

This attack can be entirely prevented by doing a length check on `msg.data`. In the case of `transfer()`, the length should be 68:

```
assert(msg.data.length == 68);
```

Vulnerable functions include all those whose last two parameters are an address, followed by a value.

In ERC20 these functions include `transferFrom` and `approve`.

A general way to implement this is with a modifier (slightly modified from one suggested by redditor `izqui9`):

```

modifier onlyPayloadSize(uint numwords) {
    assert(msg.data.length == numwords * 32 +
4); _;
}

function transfer(address _to, uint256 _value) onlyPayloadSize(2) { }

```

If an exploit of this nature were to succeed, it would arguably be the fault of the exchange, or whoever else improperly constructed the offending transactions. However, we believe in defense in depth. It's easy and desirable to make tokens which cannot be stolen this way, even from poorly-coded exchanges.

Because dividend-paying tokens execute additional code on transfer we think this issue is worth looking at more carefully than most token contracts, and recommend that at very least the assert be added to the code.

Further explanation of this attack is here:

<http://vessenes.com/the-erc20-short-address-attack-explained/>

**But Coding in this way are creating some problems with multisig wallet codings, so it is recommendable to list in secure exchanges which inherently checks the address and function arguments.**

Most of the contract are not using the payload size checking on the Solidity level to be compliant with the solidity coding standard. So the contract has done the correct thing of not including the mechanism

## 7.2 Approval Double-spend

Imagine that Alice approves Mallory to spend 100 tokens. Later, Alice decides to approve Mallory to spend 150 tokens instead. If Mallory is monitoring pending transactions, then when he sees Alice's new approval he can attempt to quickly spend 100 tokens, racing to get his transaction mined in before Alice's new approval arrives. If his transaction beats Alice's, then he can spend another 150 tokens after Alice's transaction goes through.

This issue is a consequence of the ERC20 standard, which specifies that approve() takes a replacement value but no prior value. Preventing the attack while complying with ERC20 involves some compromise: users should set the approval to zero, make sure Mallory hasn't snuck in a spend, then set the new value. In general, this sort of attack is possible with functions which do not encode enough prior state; in this case Alice's baseline belief of Mallory's outstanding spent token balance from the Mallory allowance.

It's possible for approve() to enforce this behavior without API changes in the ERC20 specification:

```
if ((_value != 0) && (approved[msg.sender][_spender] != 0)) return false;
```

However, this is just an attempt to modify user behavior. If the user does attempt to change from one non-zero value to another, then the doublespend can still happen, since the attacker



will set the value to zero.

If desired, a nonstandard function can be added to minimize hassle for users. The issue can be fixed with minimal inconvenience by taking a change value rather than a replacement value:

```
function increaseApproval (address _spender, uint256 _addedValue)
returns (bool success) {
    uint oldValue = approved[msg.sender][_spender];
    approved[msg.sender][_spender] = safeAdd(oldValue,
        _addedValue); return true;
}
```

Even if this function is added, it's important to keep the original for compatibility with the ERC20 specification.

Likely impact of this bug is low for most situations, but exchanges without preferred Mining contracts may wish to consider carefully their approve workflow.

For more, see this discussion on github:

<https://github.com/ethereum/EIPs/issues/20#issuecomment-263524729>

## 8. References

A. <https://github.com/ConsenSys/smart-contract-best-practices>

B. <https://lightrains.com/blogs/smart-contract-best-practices-solidity>

C. <https://www.gitbook.com/book/alexxtiong97/smart-contract-best-practices/details>

D. <https://blog.zeppelin.solutions/onward-with-ethereum-smart-contract-security-97a827e47702>