

# LIDO CSM SECURITY AUDIT REPORT

July 18, 2025

**MixBytes()**

# TABLE OF CONTENTS

<b>1. INTRODUCTION</b>	3
1.1 Disclaimer	3
1.2 Security Assessment Methodology	3
1.3 Project Overview	7
1.4 Project Dashboard	8
1.5 Summary of findings	13
1.6 Conclusion	16
 <b>2. FINDINGS REPORT</b>	19
<b>2.1 Critical</b>	19
<b>2.2 High</b>	19
<b>2.3 Medium</b>	19
M-1 Inconsistent Bond Curve Update Handling	19
M-2 Potential Mismanagement of Updated Withdrawal Vault Addresses	21
M-3 Unchecked Guardian Quorum Value	22
M-4 Reuse of Guardian Signatures for Pausing Deposits	23
M-5 Bond Curve is Not Reset Inside the <code>submitInitialSlashing</code> Function	24
M-6 Possible missing <code>_updateDepositableValidatorsCount</code> calls	25
M-7 Griefing of <code>CSModule.addValidatorKeysETH()</code> with <code>CSModule.depositETH()</code>	26
M-8 Griefing of <code>CSModule.compensateELRewardsStealingPenalty()</code>	27
M-9 Incorrect Check For <code>data.length</code> in the <code>AccountingOracle</code> Contract	28
M-10 Potential Misallocation of Validators in <code>_getDepositsAllocation</code> Function	29
<b>2.4 Low</b>	30
L-1 Inefficient Conversion Method in Bond Calculation	30
L-2 Lack of Validation for <code>curveId</code> in Constructor	31
L-3 Potential Front-Running Vulnerability in Reward Claim Process	32
L-4 Lack of Checks for Service Addresses	33
L-5 Lack of Existence Check for Node Operator ID	34
L-6 Missing Validation of Key Removal Charge	35
L-7 Redundant Function Definition	36
L-8 Lack of Upper Limit Validation	37

L-9 Inflexibility in Contract Pause Duration Extension	38
L-10 <code>reportELRewardsStealingPenalty</code> can be called with <code>amount</code> set to <code>0</code>	39
L-11 <code>ELRewardsStealingPenaltySettled</code> event shouldn't be emitted in some cases	40
L-12 Unused <code>AlreadyWithdrawn</code> error	41
L-13 <code>_treeCid</code> is not checked for duplicate value	42
L-14 Unused function <code>_checkProcessingDeadline()</code>	43
L-15 Unnecessary modifier <code>whenPaused</code>	44
L-16 Possibility of overflow inside an unchecked block in <code>CSBondLock._lock()</code>	45
L-17 Using of a constant value instead of a constant name in <code>CSModule.initialize()</code>	46
L-18 Missing Validation for Withdrawal Queue Limits	47
L-19 Missing Nonce Increment in <code>addNodeOperator</code> Function	48
L-20 Potential Issue with Signature Verification in <code>pauseDeposits</code> Function	49
L-21 Missing Validation of <code>depositCalldata</code> in <code>depositBufferedEther</code> Function	50
L-22 Potential Rounding Errors in <code>_getDepositsAllocation</code> Function	51
L-23 Lack of Index Validation in <code>at</code> Function	52
L-24 Missing Checks for <code>_pauseIntentValidityPeriodBlocks</code> and <code>_maxOperatorsPerUnvetting</code> Values	53
L-25 Unnecessary Inheritance	54
L-26 Incorrect Comment	55
L-27 Possible Multiple Signature Usage in <code>DepositSecurityModule.depositBufferedEther()</code>	56
L-28 Lack of <code>genesisTime</code> Check in <code>HashConsensus</code> and <code>BaseOracle</code> Constructors	57
L-29 Missing Proof Length Check in <code>getFeesToDistribute</code> Function	58
L-30 Chain Id Value is Used in the <code>DepositSecurityModule</code> Constructor	59
L-31 Missing Nonce Increment in <code>_updateRefundValidatorsKeysCount</code> Function	60
<b>3. ABOUT MIXBYTES</b>	61

# 1. INTRODUCTION

## 1.1 Disclaimer

The audit makes no statements or warranties about utility of the code, safety of the code, suitability of the business model, investment advice, endorsement of the platform or its products, regulatory regime for the business model, or any other statements about fitness of the contracts to purpose, or their bug free status.

## 1.2 Security Assessment Methodology

A group of auditors are involved in the work on the audit. The security engineers check the provided source code independently of each other in accordance with the methodology described below:

### 1. Project architecture review:

- Project documentation review.
- General code review.
- Reverse research and study of the project architecture on the source code alone.

#### Stage goals

- Build an independent view of the project's architecture.
- Identifying logical flaws.

### 2. Checking the code in accordance with the vulnerabilities checklist:

- Manual code check for vulnerabilities listed on the Contractor's internal checklist. The Contractor's checklist is constantly updated based on the analysis of hacks, research, and audit of the clients' codes.
- Code check with the use of static analyzers (i.e Slither, Mythril, etc).

#### Stage goal

Eliminate typical vulnerabilities (e.g. reentrancy, gas limit, flash loan attacks etc.).

### 3. Checking the code for compliance with the desired security model:

- Detailed study of the project documentation.
- Examination of contracts tests.
- Examination of comments in code.
- Comparison of the desired model obtained during the study with the reversed view obtained during the blind audit.
- Exploits PoC development with the use of such programs as Brownie and Hardhat.

#### Stage goal

Detect inconsistencies with the desired model.

### 4. Consolidation of the auditors' interim reports into one:

- Cross check: each auditor reviews the reports of the others.
- Discussion of the issues found by the auditors.
- Issuance of an interim audit report.

#### Stage goals

- Double-check all the found issues to make sure they are relevant and the determined threat level is correct.
- Provide the Client with an interim report.

### 5. Bug fixing & re-audit:

- The Client either fixes the issues or provides comments on the issues found by the auditors. Feedback from the Customer must be received on every issue/bug so that the Contractor can assign them a status (either "fixed" or "acknowledged").
- Upon completion of the bug fixing, the auditors double-check each fix and assign it a specific status, providing a proof link to the fix.
- A re-audited report is issued.

#### **Stage goals**

- Verify the fixed code version with all the recommendations and its statuses.
- Provide the Client with a re-audited report.

## **6. Final code verification and issuance of a public audit report:**

- The Customer deploys the re-audited source code on the mainnet.
- The Contractor verifies the deployed code with the re-audited version and checks them for compliance.
- If the versions of the code match, the Contractor issues a public audit report.

#### **Stage goals**

- Conduct the final check of the code deployed on the mainnet.
- Provide the Customer with a public audit report.

## Finding Severity breakdown

All vulnerabilities discovered during the audit are classified based on their potential severity and have the following classification:

Severity	Description
Critical	Bugs leading to assets theft, fund access locking, or any other loss of funds.
High	Bugs that can trigger a contract failure. Further recovery is possible only by manual modification of the contract state or replacement.
Medium	Bugs that can break the intended contract logic or expose it to DoS attacks, but do not cause direct loss funds.
Low	Bugs that do not have a significant immediate impact and could be easily fixed.

Based on the feedback received from the Customer regarding the list of findings discovered by the Contractor, they are assigned the following statuses:

Status	Description
Fixed	Recommended fixes have been made to the project code and no longer affect its security.
Acknowledged	The Customer is aware of the finding. Recommendations for the finding are planned to be resolved in the future.

## 1.3 Project Overview

The Community Staking Module (CSM) is a permissionless staking module designed to onboard community stakers as Node Operators within the Lido on Ethereum protocol. The primary objective of CSM is to democratize the participation in staking activities by minimizing entry barriers and fostering a decentralized network of validators.

## 1.4 Project Dashboard

### Project Summary

Title	Description
Client	Lido
Project name	CSM
Timeline	23.07.2024 - 08.07.2025
Number of Auditors	3

### Project Log

Date	Commit Hash	Note
23.07.2024	a898d045b63303294752d1a60ad9dfe8d8ba69ca	Commit for the audit (Community Staking Module)
23.07.2024	fafa232a7b3522fdee5600c345b5186b4bcb7ada	Commit for the audit (Core)
23.07.2024	6d63d68f8d01668114dc46e170a24e400976d950	Commit for the audit (EasyTrack 1)
23.07.2024	13f78f1ec44436abfb1b2a55f640e2178f79d029	Commit for the audit (EasyTrack 2)
14.08.2024	638933f0e0740e049328b6e2dba616a4b93d1e64	Commit for the audit (Data Bus)
17.09.2024	0e4b33a2a0c8679319c4befd0c92c84107fa2bd1	Commit for the re-audit (Community Staking Module)
25.09.2024	1ffbb7e49e112fcac678f59bf63ba57a7e522874	Commit for the re-audit (Core)
26.09.2024	cdc6e335ae907a5ba1160091824ce2ebe2e0842f	Commit for the re-audit 2 (Community Staking Module)

Date	Commit Hash	Note
01.10.2024	9c7d014844395b37a64b3ca4ed5dc27de0af23a5	Commit for the re-audit 3 (Community Staking Module)
07.10.2024	347496df916c3b987a7f3fe8b0bd85c9b62ad730	Commit with the update (Community Staking Module)
23.01.2025	3469910c0d29a54b37d0c4de3cf527a3e7be2099	Commit with the update (Community Staking Module)
08.07.2025	d29a0bf4dac8d78550016beb82dbf16431db5ced	Commit with the update (Community Staking Module)

## Project Scope

The audit covered the following files:

File name	Link
src/CSFeeDistributor.sol	<a href="#">CSFeeDistributor.sol</a>
src/CSAccounting.sol	<a href="#">CSAccounting.sol</a>
src/CSFeeOracle.sol	<a href="#">CSFeeOracle.sol</a>
src/CSVerifier.sol	<a href="#">CSVerifier.sol</a>
src/CSModule.sol	<a href="#">CSModule.sol</a>
src/CSEarlyAdoption.sol	<a href="#">CSEarlyAdoption.sol</a>
src/lib/base-oracle/HashConsensus.sol	<a href="#">HashConsensus.sol</a>
src/lib/base-oracle/BaseOracle.sol	<a href="#">BaseOracle.sol</a>
src/lib/SigningKeys.sol	<a href="#">SigningKeys.sol</a>
src/lib/proxy/OssifiableProxy.sol	<a href="#">OssifiableProxy.sol</a>
src/lib/TransientUintUintMapLib.sol	<a href="#">TransientUintUintMapLib.sol</a>

File name	Link
src/lib/NOAddresses.sol	NOAddresses.sol
src/lib/ValidatorCountsReport.sol	ValidatorCountsReport.sol
src/lib/utils/PausableUntil.sol	PausableUntil.sol
src/lib/utils/Versioned.sol	Versioned.sol
src/lib/Types.sol	Types.sol
src/lib/SSZ.sol	SSZ.sol
src/lib/GIndex.sol	GIndex.sol
src/lib/QueueLib.sol	QueueLib.sol
src/lib/AssetRecovererLib.sol	AssetRecovererLib.sol
src/lib/UnstructuredStorage.sol	UnstructuredStorage.sol
src/abstract/CSBondLock.sol	CSBondLock.sol
src/abstract/CSBondCurve.sol	CSBondCurve.sol
src/abstract/CSBondCore.sol	CSBondCore.sol
src/abstract/AssetRecoverer.sol	AssetRecoverer.sol
contracts/0.4.24/nos/NodeOperatorsRegistry.sol	NodeOperatorsRegistry.sol
contracts/0.8.9/DepositSecurityModule.sol	DepositSecurityModule.sol
contracts/0.8.9/StakingRouter.sol	StakingRouter.sol
contracts/0.8.9/oracle/AccountingOracle.sol	AccountingOracle.sol
contracts/0.8.9/sanity_checks/OracleReportSanityChecker.sol	OracleReportSanityChecker.sol

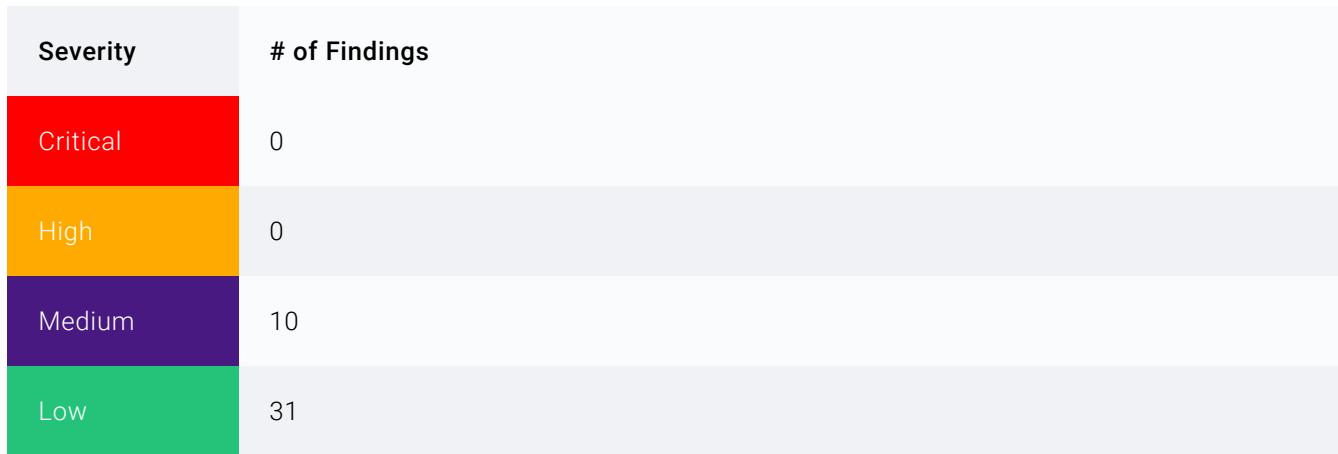
File name	Link
contracts/common/lib/MinFirstAllocationStrategy.sol	MinFirstAllocationStrategy.sol
contracts/EVMScriptFactories/UpdateTargetValidatorLimits.sol	UpdateTargetValidatorLimits.sol
contracts/EVMScriptFactories/CSMSettleELStealingPenalty.sol	CSMSettleELStealingPenalty.sol
contracts/DataBus.sol	DataBus.sol

## Deployments

File name	Contract deployed on mainnet	Comment
OssifiableProxy.sol	0xdA7dE2EcDfccC6c3AF10108Db212ACBBf9EA83F	Proxy for CSModule.sol
CSModule.sol	0x8daEa53b17a629918CDFAB785C5c74077c1D895B	
CSVerifier.sol	0xec6cc185f671f627fb9b6f06c8772755f587b05d	
CSEarlyAdoption.sol	0x3D5148ad93e2ae5DedD1f7A8B3C19E7F67F90c0E	
OssifiableProxy.sol	0x4d72BFF1BeaC69925F8Bd12526a39BAAb069e5Da	Proxy for CSAccounting.sol
CSAccounting.sol	0x71FCD2a6F38B644641B0F46c345Ea03Daabf2758	
OssifiableProxy.sol	0xD99CC66fEC647E68294C6477B40fc7E0F6F618D0	Proxy for CSFeeDistributor.sol
CSFeeDistributor.sol	0x17Fc610ecbbAc3f99751b3B2aAc1bA2b22E444f0	
OssifiableProxy.sol	0x4D4074628678Bd302921c20573EEa1ed38DdF7FB	Proxy for CSFeeOracle.sol
CSFeeOracle.sol	0x919ac5C6c62B6ef7B05cF05070080525a7B0381E	

<b>File name</b>	<b>Contract deployed on mainnet</b>	<b>Comment</b>
HashConsensus.sol	0x71093efF8D8599b5fA340D665Ad60fA7C80688e4	
AssetRecovererLib.sol	0xa74528edc289b1a597Faf83fCfF7eFf871Cc01D9	
NOAddresses.sol	0xF8E5de8bAf8Ad7C93DCB61D13d00eb3D57131C72	
QueueLib.sol	0xD19B40Cb5401f1413D014A56529f03b3452f70f9	
MinFirstAllocationStrategy.sol	0x7e70De6D1877B3711b2bEDa7BA00013C7142d993	
StakingRouter.sol	0x89eDa99C0551d4320b56F82DDE8dF2f8D2eF81aA	
NodeOperatorsRegistry.sol	0x1770044a38402e3CfCa2Fcfa0C84a093c9B42135	
DepositSecurityModule.sol	0xfFA96D84dEF2EA035c7AB153D8B991128e3d72fD	
AccountingOracle.sol	0x0e65898527E77210fB0133D00dd4C0E86Dc29bC7	
OracleReportSanityChecker.sol	0x6232397ebac4f5772e53285B26c47914E9461E75	
UpdateTargetValidatorLimits.sol	0x161a4552A625844c822954C5AcBac928ee0f399B	
CSMSettleEIStealingPenalty.sol	0xF6B6E7997338C48Ea3a8BCfa4BB64a315fDa76f4	

## 1.5 Summary of findings



ID	Name	Severity	Status
M-1	Inconsistent Bond Curve Update Handling	Medium	Acknowledged
M-2	Potential Mismanagement of Updated Withdrawal Vault Addresses	Medium	Fixed
M-3	Unchecked Guardian Quorum Value	Medium	Acknowledged
M-4	Reuse of Guardian Signatures for Pausing Deposits	Medium	Acknowledged
M-5	Bond Curve is Not Reset Inside the <code>submitInitialSlashing</code> Function	Medium	Acknowledged
M-6	Possible missing <code>_updateDepositableValidatorsCount</code> calls	Medium	Acknowledged
M-7	Griefing of <code>CSModule.addValidatorKeysETH()</code> with <code>CSModule.depositETH()</code>	Medium	Fixed
M-8	Griefing of <code>CSModule.compensateELRewardsStealingPenalty()</code>	Medium	Fixed
M-9	Incorrect Check For <code>data.length</code> in the <code>AccountingOracle</code> Contract	Medium	Fixed
M-10	Potential Misallocation of Validators in <code>_getDepositsAllocation</code> Function	Medium	Acknowledged

L-1	Inefficient Conversion Method in Bond Calculation	Low	Fixed
L-2	Lack of Validation for <code>curveId</code> in Constructor	Low	Acknowledged
L-3	Potential Front-Running Vulnerability in Reward Claim Process	Low	Fixed
L-4	Lack of Checks for Service Addresses	Low	Acknowledged
L-5	Lack of Existence Check for Node Operator ID	Low	Acknowledged
L-6	Missing Validation of Key Removal Charge	Low	Fixed
L-7	Redundant Function Definition	Low	Acknowledged
L-8	Lack of Upper Limit Validation	Low	Acknowledged
L-9	Inflexibility in Contract Pause Duration Extension	Low	Acknowledged
L-10	<code>reportELRewardsStealingPenalty</code> can be called with <code>amount</code> set to 0	Low	Fixed
L-11	<code>ELRewardsStealingPenaltySettled</code> event shouldn't be emitted in some cases	Low	Fixed
L-12	Unused <code>AlreadyWithdrawn</code> error	Low	Fixed
L-13	<code>_treeCid</code> is not checked for duplicate value	Low	Fixed
L-14	Unused function <code>_checkProcessingDeadline()</code>	Low	Fixed
L-15	Unnecessary modifier <code>whenPaused</code>	Low	Fixed
L-16	Possibility of overflow inside an unchecked block in <code>CSBondLock._lock()</code>	Low	Fixed
L-17	Using of a constant value instead of a constant name in <code>CSModule.initialize()</code>	Low	Fixed
L-18	Missing Validation for Withdrawal Queue Limits	Low	Acknowledged
L-19	Missing Nonce Increment in <code>addNodeOperator</code> Function	Low	Acknowledged

L-20	Potential Issue with Signature Verification in <code>pauseDeposits</code> Function	Low	Acknowledged
L-21	Missing Validation of <code>depositCallData</code> in <code>depositBufferedEther</code> Function	Low	Acknowledged
L-22	Potential Rounding Errors in <code>_getDepositsAllocation</code> Function	Low	Acknowledged
L-23	Lack of Index Validation in <code>at</code> Function	Low	Acknowledged
L-24	Missing Checks for <code>_pauseIntentValidityPeriodBlocks</code> and <code>_maxOperatorsPerUnvetting</code> Values	Low	Acknowledged
L-25	Unnecessary Inheritance	Low	Acknowledged
L-26	Incorrect Comment	Low	Fixed
L-27	Possible Multiple Signature Usage in <code>DepositSecurityModule.depositBufferedEther()</code>	Low	Acknowledged
L-28	Lack of <code>genesisTime</code> Check in <code>HashConsensus</code> and <code>BaseOracle</code> Constructors	Low	Acknowledged
L-29	Missing Proof Length Check in <code>getFeesToDistribute</code> Function	Low	Fixed
L-30	Chain Id Value is Used in the <code>DepositSecurityModule</code> Constructor	Low	Acknowledged
L-31	Missing Nonce Increment in <code>_updateRefundValidatorsKeysCount</code> Function	Low	Fixed

## 1.6 Conclusion

During the audit, we thoroughly tested critical attack vectors and verified the following:

- It is impossible to initialize or compromise contract implementations. The `Versioned` contract is used in upgradeable contracts. It helps control the contract version and ensures that any upgrades correctly increase the contract version number. Each `initialize` function is properly protected by the `onlyInit` modifier or by the check inside the `Versioned` contract, which ensures that the current contract version is equal to 0 (can be initialized), and each `finalizeUpgrade` function can be called only if there has been no previous upgrade to the target contract version.
- `calldata` parameters cannot be exploited to upload invalid keys. It is possible to add invalid deposit data, but it won't be used to perform a deposit to the Beacon Chain. Also, each added set of validator data requires a bond to be deposited, so there is an economical disincentive to provide invalid data. Even if attempted, off-chain services would detect and reject them. `bytes` arrays passed as `calldata` are correctly processed. For `publicKeys` and `signatures`, when a new validator is created, the `SigningKeys` library is used to read public keys and signatures from the `bytes` arrays provided in `calldata`. In case any incorrect validator data is added, there is an unvetting functionality. It is used to mark stored keys and signatures as invalid to prevent their use as deposit data in the future.
- Tiny deposits from random external accounts to a Node Operator's bond are safely handled as donations, without affecting internal logic. It is possible to deposit ETH, stETH, or wstETH to the CSModule. This can be done by anyone, but only to an existing Node Operator. All such deposits are accounted for in the Node Operator's bond. During each deposit, an internal function `_increaseBond` is invoked to update the bond shares counters.
- The minimum bond for active validators is correctly enforced by the CSAccounting contract. There are multiple functions, such as `_getUnbondedKeysCount` and `getRequiredBondForNextKeys`, which use bond curves for Node Operators to determine how much bond is needed for the number of added validator keys. These functions also check if there is any locked bond due to reported slashings or EL rewards stealing.
- If a node operator removes keys before unvetting, the fee and nonce checks in DSM prevent misuse. There is an `unvetSigningKeys` function in the `DepositSecurityModule` contract which checks that the nonce of the staking module matches the nonce provided to DSM with the unvet message. If a user decides to call `removeKeys` right before the `decreaseVettedSigningKeysCount` is called by the Staking Router, they would be charged a fee for each removed key and the staking module nonce would be increased. These checks and charges make such an attack worthless.
- The `_updateDepositableValidatorsCount` function is secure against underflow. All calculations in this function are performed after checks that ensure there are no reverts or underflows inside unchecked blocks. The most important part is accounting for unbonded, stuck, and non-deposited validator counts. This affects the `newCount` variable, which is used to update the `depositableValidatorsCount` variable for a particular Node Operator.

- A node operator in the CSModule can remove multiple keys with minimal charges if they were slashed, which is intentional behavior. If there is a locked bond after the Node Operator penalization, and a user tries to remove not-yet-deposited validator keys, then the `keyRemovalCharge` should be deducted from the Node Operator's bond. However, if the key removal charge is larger than the current Node Operator bond, the `_reduceBond` function in the `CSBondCore` contract would reduce the bond only by the current amount of shares. Despite being a highly unlikely scenario, this case was thoroughly checked and there weren't any additional attack vectors discovered.
- There is a known delay in processing reports, which may cause the `availableValidatorsCount` to temporarily show a lower value than expected. There is a multi-phased oracle report processing system in place. In the first phase, exited validators' counts are updated only in the Staking Router, and during the second phase, oracle reports update stuck and exited validators' counts directly to the staking modules. Additionally, stuck and exited validators' data is reported in multiple consecutive transactions, which allows for separating extra report data into chunks.
- The `addNodeOperatorStETH` and `addNodeOperatorWstETH` functions correctly process `permit` front-running. If anyone decides to front-run a call to either of the mentioned functions with specified permit data, it will not break the staking module logic or result in depositing on behalf of another user.
- Adding multiple Node Operators with just one validator key doesn't lead to contract DoS. In such cases, each validator key would be added to the queue as a separate batch, which theoretically could lead to out-of-gas errors if there are any loops going over the whole queue. However, each function that accesses the queue uses special arguments which limit the number of iterations. For example, there is `maxItems` for the queue `clean` function and `maxDepositsPerBlock` in `DepositSecurityModule`, which is then used as `depositsCount` in the `obtainDepositData` function.
- It is impossible to withdraw bond shares belonging to Node Operators from the `CSAccounting` contract using the `recoverStETHShares` function. If any stETH shares were mistakenly sent directly to the `CSAccounting` contract, they can still be recovered. The recoverable amount is calculated using the contract balance minus the totalBondShares belonging to the Node Operators' bonds.
- Reports with an incorrect `refSlot` are filtered in the `HashConsensus` contract. There is a `_checkConsensus` function which ensures that the submitted report is at the correct `refSlot` of the frame and that a report with the provided `refSlot` hasn't been submitted for processing earlier.
- Each operation that changes the number of validator keys leads to a staking module nonce increment. All functions that lead to a change in the number of validator keys were thoroughly checked to update the module nonce, so that off-chain services and the Deposit Security Module can check it against the tracked value.

### **CSVerifier contract update (presented in the commit `CSVerifier.sol`):**

The voting script presented in [PR-435](#) rotates the `CSVerifier` contract configured in the Community Staking Module (CSM) from the old implementation ([0x0c345dFa318f9F4977cdd4f33d80F9D0ffA38e8B](#)) to the new

one ([0xeC6Cc185f671F627fb9b6f06C8772755F587b05d](#)). The script was reviewed, and it was confirmed that the rotation is performed correctly by transferring the `VERIFIER_ROLE` from the old address to the new one, as seen in steps 17–18 of the script.

## 2. FINDINGS REPORT

### 2.1 Critical

Not Found

### 2.2 High

Not Found

### 2.3 Medium

M-1	Inconsistent Bond Curve Update Handling
Severity	Medium
Status	Acknowledged

#### Description

The issue is identified within the function `CSAccounting.sol#L168-L173` of contract `CSAccounting`. When updating a bond curve, there is a potential issue where the unbonded validators amount increases for a specific NO (node operator), but the corresponding depositable amount is not updated accordingly. This inconsistency can lead to unexpected behavior in the system, as the depositable amount should be forced to update, but currently, it is not possible to enforce this.

The issue is classified as **Medium** severity because it can result in inconsistencies within the contract's logic, potentially leading to deposits of NO's keys without appropriate bond.

#### Recommendation

We recommend conducting bond curve update in a 2-step way, when NO's curve Id is updated on any action of this NO which will guarantee that unbonded keys and depositable keys update simultaneously.

#### Client's commentary

Making a two-step change might be complicated. Also, it is assumed that in most cases, the curve would be changed to lower values than the current one. However, should the curve be changed to higher values, the `normalizeQueue` method can be called individually for each NO with the change curve since the `normalizeQueue` method was changed to permissionless after the start of the audits.

M-2	Potential Mismanagement of Updated Withdrawal Vault Addresses
Severity	Medium
Status	Fixed in 0e4b33a2

## Description

The issue is identified within the function `CSVerifier.sol#L308-L310` of the contract `CSVerifier`. The current implementation verifies that the `withdrawalAddress` matches `WITHDRAWAL_ADDRESS`. However, if the withdrawal vault address is updated through a contract upgrade, this check may fail for old deposits, leading to incorrect handling of those withdrawal processes.

The issue is classified as **Medium** severity because it can cause inconsistencies in withdrawal processing, potentially affecting users' funds and the contract's reliability.

## Recommendation

We recommend implementing a mechanism to track historical withdrawal vault addresses or ensuring backward compatibility when updating the withdrawal vault address.

## Client's commentary

It's possible to have multiple instances of `CSVerifier` attached via the `VERIFIER_ROLE` role to the `CSModule` with different `WITHDRAWAL_ADDRESS`'es configured. A user should just use the correct instance to bring its proof.

M-3	Unchecked Guardian Quorum Value
<b>Severity</b>	Medium
<b>Status</b>	Acknowledged

## Description

The issue is identified within the [DepositSecurityModule.sol#L247-L254](#) function of the [DepositSecurityModule](#) contract. The function allows setting a guardian quorum value without checking if it exceeds the number of active guardians.

The issue is classified as **Medium** severity because it could lead to operational disruptions and governance issues if the quorum set is greater than the number of available guardians.

## Recommendation

We recommend introducing a validation step within the [\\_setGuardianQuorum](#) function to ensure that the new quorum value does not exceed the current number of guardians.

## Client's commentary

Changing the quorum can only be done through on-chain voting. All parameters are double-checked, acceptance tests are expected to be written for each vote, and any inflated quorum value can be corrected by subsequent voting. The absence of the check is intentional, and this behavior is documented in the code.

M-4	Reuse of Guardian Signatures for Pausing Deposits
<b>Severity</b>	Medium
<b>Status</b>	Acknowledged

### Description

The issue is identified within the `DepositSecurityModule.sol#L384` function of the `DepositSecurityModule` contract. This function checks for guardians' signatures to pause deposits but does not utilize a nonce mechanism. Consequently, a previously used signature could potentially be replayed to initiate another pause, leading to abuse or unintended operational disruptions.

The issue is classified as **Medium** severity because it could allow an attacker to repeatedly pause the system by reusing an old, valid signature, thereby disrupting normal operations and potentially causing governance issues.

### Recommendation

We recommend implementing a nonce system for signing operations. This will prevent the reuse of signatures and enhance the security and robustness of the contract.

### Client's commentary

The DSM setup assumes that the unpausing of deposits can only be performed through on-chain DAO voting, the duration of which is significantly shorter than the expiration time of the pause intention. Therefore, by the time the pause is lifted, all signed pause intentions will have expired.

M-5	Bond Curve is Not Reset Inside the <code>submitInitialSlashing</code> Function
Severity	Medium
Status	Acknowledged

## Description

The issue is identified within the `CSModule.sol#L1174` function of the `CSModule` contract, where the initial slashing penalty is applied to the Node Operator bond. While this penalization occurs, the Bond Curve for that Node Operator is not reset to the default.

The issue is classified as **Medium** severity because it may lead to incorrect accounting of the unbonded validator keys count after the Node Operator penalization.

## Recommendation

We recommend resetting the Node Operator bond curve during the mentioned penalization event via a call to `accounting.resetBondCurve(nodeOperatorId)`.

## Client's commentary

The corresponding bond curve reset is done within the `submitWithdrawal` method `CSModule.sol#L1139`. It is done intentionally to prevent unnecessary unbonded validators that might occur after slashing reporting but before withdrawal reporting that will reduce totalKeysCount used to calculate required bond.

M-6	Possible missing <code>_updateDepositableValidatorsCount</code> calls
<b>Severity</b>	Medium
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `CSAccounting.sol#L178` and `CSAccounting.sol#L188` functions of the `CSAccounting` contract.

It is expected that the mentioned functions may be called by an external trusted entity like DAO. The functions change Node Operator bond curve which may lead to unbonded validator keys count change.

The issue is classified as **Medium** severity because it may lead to incorrect accounting of unbonded validator keys count after the Node Operator bond curve update.

## Recommendation

We recommend making the calls to `setBondCurve` and `resetBondCurve` functions only from `CSModule` contract. Such calls should be followed by the `_updateDepositableValidatorsCount` calls which will update depositable validators count. In the future, when the DAO would be permitted to call the mentioned functions, the entry point for such calls would be inside the `CSModule` contract with all necessary updates.

## Client's commentary

Similarly to the finding #1 it is proposed to call `normalizeQueue` after calling `setBondCurve` and `resetBondCurve` externally.

M-7	Griefing of <code>CSModule.addValidatorKeysETH()</code> with <code>CSModule.depositETH()</code>
Severity	Medium
Status	Fixed in 0e4b33a2

## Description

`CSModule.addValidatorKeysETH()` CSModule.sol#L388-L393 that `msg.value` is equal to `accounting.getRequiredBondForNextKeys()`. `accounting.getRequiredBondForNextKeys()` CSAccounting.sol#L527 that relies on the current node operator's bond. The `CSModule.depositETH()` CSModule.sol#L471-L481 so anyone can increase the Node Operator's bond. A griefer may front-run a call to `accounting.getRequiredBondForNextKeys()` and deposit a few weis for 1 bond share. This would cause the initial call to revert. The griefer can do this multiple times, forcing the node operator manager to use another function for adding keys.

Additionally, a potential DoS vector exists if a user deposits 0 wei of ETH. This could block deposits of new keys initiated from the DSM contract because of the nonce update.

## Recommendation

We recommend making `CSModule.depositETH()` permissioned so that only the Node Operator manager can call it. Additionally, we recommend adding a minimum limit for ETH deposit amounts and using private pools for deposits through the DSM contract.

## Client's commentary

Check for `msg.value` changed to 'less than' via b17b4eb9. Described DoS attack vector is not applicable, since 0 wei deposits doesn't lead to a nonce change if there's no new depositable keys observed.

M-8	Griefing of <code>CSModule.compensateELRewardsStealingPenalty()</code>
<b>Severity</b>	Medium
<b>Status</b>	Fixed in 0e4b33a2

## Description

`CSModule.compensateELRewardsStealingPenalty()` [CSModule.sol#L1096-L1108](#). At the same time `CSBondLock.sol#L126-L128 to compensate no more than what was locked. A griefer may frontrun a CSModule.compensateELRewardsStealingPenalty() call and compensate 1 locked share, causing the initial call to revert. The griefer can do this multiple times, putting the Node Operator manager at risk of having to settle their lock with a reset of the bond curve.`

## Recommendation

We recommend making the `CSModule.compensateELRewardsStealingPenalty()` function permissioned so that only the Node Operator manager can call it.

## Client's commentary

Fixed via [1c9532ab](#)

M-9	Incorrect Check For <code>data.length</code> in the <code>AccountingOracle</code> Contract
Severity	Medium
Status	Fixed in <code>1ffbb7e4</code>

## Description

The issue is identified within the `AccountingOracle.sol#L741` function of the contract `NodeOperatorsRegistry`.

There is a check whether `data.length` is smaller than 67 bytes, which is incorrect, because its length should be 72 bytes minimum (`nextHash (32 bytes) + itemIndex (3 bytes) + itemType (2 bytes) + itemPayload (moduleId (3 bytes) + nodeOpsCount (8 bytes) + nodeOperatorIds (8 bytes * nodeOpsCount) + validatorsCounts (16 bytes * nodeOpsCount))`).

The issue is classified as **Medium** severity because it could lead to processing data in an incorrect format, despite the fact that it is provided in a permissioned way.

## Recommendation

We recommend changing the check to `data.length < 72` to disallow incorrect data processing

## Client's commentary

The check has been completely removed in commit `beb6ceb23cc3b54a74e74e25f1f9aeda65d04afe03e` as it looks redundant. Incorrect data is checked further in the code in `_processExtraDataItem`

M-10	Potential Misallocation of Validators in <code>_getDepositsAllocation</code> Function
Severity	Medium
Status	Acknowledged

## Description

The issue is identified within the `StakingRouter.sol#L1406-L1434` function of the contract `stakingRouter`. If a deposit is made before the system updates the status of stuck validators, there is a risk that funds could be allocated to a Node Operator (NO) that has violated an exit request. This can occur because the calculation uses `availableValidatorsCount`, which may not reflect the true status if stuck validators have not been accounted for yet.

The issue is classified as **Medium** severity because it could lead to the misallocation of validators, resulting in staking funds being deposited into a node operator that is not operating properly or has violated an exit request. The most probable scenario is when NO loses private keys for validators and cannot exit them. In this case, the protocol may allocate new deposits for such NO if the deposit is made before the stuck keys update.

## Recommendation

We recommend implementing a mechanism to ensure that the status of all validators, especially stuck validators, is updated before deposits are made. This can be done by adding a flag to the `AccountingOracle` contract that prevents new deposits from being made after a new report is submitted until the stuck validators update is finalized.

## Client's Commentary

It is assumed that operators in the curated modules receive only half of the rewards and do not receive a new stake if they do not exit keys in the time specified in the policy. This feature is intended to incentivize operators to exit keys on time, but is not a security tool to limit the new stake on an operator. To limit the stake on a particular operator, DAO has another tool: target limit.

## 2.4 Low

L-1	Inefficient Conversion Method in Bond Calculation
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

### Description

The issue is identified within the [CSAccounting.sol#L535-L572](#) view functions of the contract [CSAccounting](#). The function currently uses `WSTETH.getWstETHByStETH()` to convert stEth amount to shares. However, it would be more efficient to use `_sharesByEth()` instead of `WSTETH.getWstETHByStETH()` for the conversion process.

The issue is classified as **Low** severity because it does not impact the security or core functionality but could lead to inefficiencies.

### Recommendation

We recommend replacing the use of `WSTETH.getWstETHByStETH()` with `_sharesByEth()` in the functions from the description to improve efficiency and consistency in bond calculations.

### Client's commentary

Fixed via [aafdf9984](#)

L-2	Lack of Validation for <code>curveId</code> in Constructor
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

### Description

The issue is identified within the `CSEarlyAdoption.sol#L34` of the `CSEarlyAdoption` contract. While the `curveId` parameter is required and checked for being non-zero, there is no validation to ensure that the provided `curveId` is valid within the system. This could lead to the assignment of an invalid or non-existent bond curve, potentially causing issues during the contract's operation.

The issue is classified as **Low** severity because it does not immediately affect the contract's security or functionality but could lead to future issues if an invalid `curveId` is used.

### Recommendation

We recommend adding a validation step to ensure that the `curveId` provided during the contract's deployment corresponds to a valid bond curve in the system.

### Client's commentary

Deploy parameters and deployment itself are manually validated to ensure correctness.

L-3	Potential Front-Running Vulnerability in Reward Claim Process
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

### Description

The issue is identified within the `CSModule.sol#L548-L554` function of the `CSModule` contract. Specifically, the process might be vulnerable to a front-running attack, where an attacker could front-run the function to claim an unfair amount of funds. This could occur in scenarios where NO has stolen EL rewards and is punished for it but manages to front-run reporting of stealing and claims an unfair amount.

The issue is classified as **Low** severity because while this vulnerability could allow an attacker to claim more rewards than intended, it requires precise timing and specific conditions, limiting its overall impact.

### Recommendation

We recommend using private pools for EL rewards stealing reporting.

### Client's commentary

There is also a chance to claim rewards right before the block proposal if Node Operator is planning to steal MEV. Private pools will be used by the corresponding role member.

L-4	Lack of Checks for Service Addresses
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `CSModule` contract. Specifically, there is a potential concern if the `rewardAddress` or `managerAddress` address of a Node Operator is one of the service addresses (`CSAccounting` for example). This could result in the user bond being reduced, and some funds becoming stuck in the accounting. Although this situation might seem acceptable under current conditions, it would be more robust to include appropriate checks during the initialization phase to prevent such scenarios.

The issue is classified as **Low** severity because the current implementation could lead to inefficiencies in fund management, though it does not directly compromise the security or functionality of the system.

## Recommendation

We recommend adding validation checks during the Node Operator initialization phase to ensure that neither the `rewardAddress` nor the `managerAddress` address is one of the service addresses.

## Client's commentary

Service addresses are not the only addresses that can cause issues if used as a manager or reward address. It is the user's responsibility to set the addresses correctly.

Misdirected funds can be recovered for the majority of the CSM contracts.

L-5	Lack of Existence Check for Node Operator ID
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the [CSModule.sol#L1447](#) function of the contract. The function currently does not check whether the provided `nodeOperatorId` corresponds to an existing node operator, potentially leading to the retrieval of incorrect or uninitialized data if an invalid ID is queried. This oversight could result in unexpected behavior or errors when interacting with the contract. The same issue is present for [CSBondCurve.sol#L75-L79](#) and [CSBondCurve.sol#L84-L88](#) functions.

The issue is classified as **Low** severity because, while it might lead to incorrect data being returned and potentially misleading the users or administrators of the contract, it does not directly compromise the contract's security.

## Recommendation

We recommend implementing a validation step at the beginning of the `getNodeOperatorSummary`, `getBondCurve` and `getBondCurveId` functions to ensure that the `nodeOperatorId` exists in the system before proceeding with the rest of the function.

## Client's commentary

Since the methods mentioned are view methods, it is proposed that inputs be verified off-chain. All on-chain calls of the methods outlined already contain Node Operator existence validation.

L-6	Missing Validation of Key Removal Charge
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

### Description

The issue is identified within the function [CSModule.sol#L1674-L1677](#) of the contract. This function currently allows setting any amount for the key removal charge without enforcing a limit. Without an upper boundary, excessively high charges could be set, potentially creating barriers for node operators needing to remove keys or manage their nodes effectively.

The issue is classified as **Low** severity because while it could lead to operational inefficiencies or financial burdens for Node Operators, it does not directly compromise the contract's security.

### Recommendation

We recommend implementing a cap on the key removal charge to ensure it remains within reasonable limits.

### Client's commentary

Fixed via [982e236d](#)

L-7	Redundant Function Definition
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

### Description

The issue is identified within the `CSBondCore.sol#L275-L279` function of the `CSBondCore` contract. This function is redundant as it is overridden in the `CSAccounting` contract, suggesting that its definition in the current context might be unnecessary. This redundancy could lead to confusion and potential maintenance issues, as developers might overlook which version of the function is being called in different contexts.

The issue is classified as **Low** severity because it primarily affects the clarity and maintainability of the code rather than its functionality or security.

### Recommendation

We recommend removing the `_getClaimableBondShares` function from the current contract to streamline the codebase and avoid confusion.

### Client's commentary

This function is kept in the code base to ensure no issues in case of partial code reuse in the other projects that will decide not to use the CSBondCurve abstract contract.

L-8	Lack of Upper Limit Validation
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

### Description

The issue is identified within the [CSBondCurve.sol#L59](#) of the [CSBondCurve](#) contract. While there is a check to ensure the maximum curve length is not below a minimum threshold, there is no upper limit enforced for the maximum curve length. This lack of upper-limit validation could potentially lead to excessively long bond curves being created.

The issue is classified as **Low** severity because it primarily affects the potential efficiency and operability of the contract rather than posing a direct security risk.

### Recommendation

We recommend introducing a reasonable upper limit for the maximum curve length during the initialization of the contract.

### Client's commentary

Deploy parameters and deployment itself are manually validated to ensure correctness.

L-9	Inflexibility in Contract Pause Duration Extension
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `PausableUntil.sol#L59-L70` function of the `PausableUntil` contract. Currently, the function does not allow for the prolongation of an existing pause duration. Once set, the pause duration is fixed until it expires. This lack of flexibility could lead to poor user experience, especially in scenarios where extending a pause without resuming the contract would be beneficial.

The issue is classified as **Low** severity because it pertains to the user experience and administrative flexibility rather than the core functionality or security of the contract.

## Recommendation

We recommend enhancing the `_pauseFor` function to allow for the extension of the current pause duration.

## Client's commentary

This functionality was borrowed from the core protocol code. It is preferable to keep it consistent with the existing protocol.

L-10

`reportELRewardsStealingPenalty` can be called with `amount` set to 0

**Severity**

Low

**Status**

Fixed in 0e4b33a2

## Description

The issue is identified within the `CSModule.sol#L1014` function of the `CSModule` contract. The mentioned function can be called with `amount` set to 0. In that case, only `EL_REWARDS_STEALING_FINE` is applied, and the `ELRewardsStealingPenaltyReported` event with `stolenAmount == 0` is emitted.

The issue is classified as **Low** severity because it requires a mistake made by the `REPORT_EL_REWARDS_STEALING_PENALTY_ROLE` role owner.

## Recommendation

We recommend restricting calls to the `reportELRewardsStealingPenalty` with the `amount` parameter set to 0.

## Client's commentary

Fixed via [7c3df56c](#)

L-11

`ELRewardsStealingPenaltySettled` event shouldn't be emitted in some cases

**Severity**

Low

**Status**

Fixed in 0e4b33a2

## Description

The issue is identified within the `CSModule.sol#L1089` function of the `CSModule` contract. This function emits `ELRewardsStealingPenaltySettled` event even if the retention period for the locked bond has passed.

The issue is classified as **Low** severity because it may lead to an incorrect event being emitted when the penalty wasn't actually settled.

## Recommendation

We recommend emitting the `ELRewardsStealingPenaltySettled` event only if `lockedBondBefore > 0` is returned from the `accounting.settleLockedBondETH(nodeOperatorId)` call.

## Client's commentary

Fixed via [143c4fb8](#)

L-12	Unused <code>AlreadyWithdrawn</code> error
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

### Description

The issue is identified at the `CSModule.sol#L155` in the `CSModule` contract. The mentioned error is unused despite the check in the `CSModule.sol#L1131` function where `AlreadySubmitted` error is used instead.

The issue is classified as **Low** severity because there is a potentially misused error that doesn't affect protocol functionality.

### Recommendation

We recommend removing the unused error or changing `AlreadySubmitted` error inside the `submitWithdrawal` function.

### Client's commentary

Fixed via `fd2e869a`

L-13	<code>_treeCid</code> is not checked for duplicate value
Severity	Low
Status	Fixed in 0e4b33a2

## Description

The issue is identified within the `CSFeeDistributor.sol#L129` function of the `CSFeeDistributor` contract.

`_treeCid` should be checked against the previously stored value as it should also be changed when the tree root changes.

The issue is classified as **Low** severity because it is possible to start processing an oracle report with an unchanged `treeCID`.

## Recommendation

We recommend adding a `revert` statement for cases when `_treeCid == treeCid`.

## Client's commentary

Fixed via `dca28fd0`

L-14	Unused function <code>_checkProcessingDeadline()</code>
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

## Description

The issue is identified at the [BaseOracle.sol#L410](#) in the `BaseOracle` contract. The `_checkProcessingDeadline()` function, which doesn't accept parameters, is never used.

The issue is classified as **Low** severity because there is an alternative function `_checkProcessingDeadline(uint256 deadlineTime)` which is used inside the `_startProcessing` function.

## Recommendation

We recommend removing the mentioned unused function.

## Client's commentary

Fixed via [19ebb5d5](#)

L-15	Unnecessary modifier <code>whenPaused</code>
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

## Description

The issue is identified within the `CSFeeOracle.sol#L139` function of the `CSFeeOracle` contract. There is an unnecessary `whenPaused` modifier used because there is a `_checkPaused` check inside the `_resume` function at the `PausableUntil.sol#L54`.

The issue is classified as **Low** severity because it doesn't affect the protocol functionality, but the unnecessary modifier removal can improve its efficiency.

## Recommendation

We recommend removing the mentioned unnecessary modifier from the `resume` function.

## Client's commentary

Fixed via `a0dc831e`

L-16

Possibility of overflow inside an unchecked block in `CSBondLock._lock()`

**Severity**

Low

**Status**

Fixed in 0e4b33a2

## Description

If `CSModule.sol#L1014` is called by mistake with `amount` parameter close to `type(uint256).max` and the node operator already has locked bond, an overflow inside an unchecked block in `CSBondLock._lock()` may happen. So stored node operator's lock becomes less than it should be.

## Recommendation

We recommend moving

```
if ($.bondLock[nodeOperatorId].retentionUntil > block.timestamp) {  
    amount += $.bondLock[nodeOperatorId].amount;  
}
```

outside of the unchecked block.

## Client's commentary

Fixed via [583338b3](#)

L-17	Using of a constant value instead of a constant name in <code>CSModule.initialize()</code>
<b>Severity</b>	Low
<b>Status</b>	Fixed in 0e4b33a2

## Description

`_pauseFor(type(uint256).max);` in `CSModule.sol#L206-L207` in `CSModule.initialize()` for an infinite pause. However, `PausableUntil.PAUSE_INFINITELY` is a special constant for this purpose.

## Recommendation

We recommend changing

`_pauseFor(type(uint256).max);`

to

`_pauseFor(PAUSE_INFINITELY);`

in `CSModule.initialize()`.

## Client's commentary

Fixed via [5d822028](#)

L-18	Missing Validation for Withdrawal Queue Limits
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the function `CSBondCore.sol#L187-L190` of the contract `CSBondCore`. The current implementation does not validate the minimum and maximum limits imposed by the withdrawal queue when processing withdrawal requests. This omission can lead to unexpected behavior, as withdrawal requests that fall outside these limits will be rejected.

The issue is classified as **Low** severity because it can disrupt the withdrawal process, leading to unexpected reverts for users.

## Recommendation

We recommend implementing checks to ensure that the requested withdrawal amounts adhere to the withdrawal queue's minimum and maximum limits.

## Client's commentary

Client: The described checks are already present in the corresponding WQ method:

`WithdrawalQueue.sol#L395-L402`. Given that, the revert is inevitable. Hence, it is not clear what unexpected behavior can occur.

MixBytes: Reverting inside the `CSModule` contract is more straightforward for users, rather than passing incorrect withdrawal amounts to the `WithdrawalQueue` contract and reverting there.

Client: Revert in the external contract seems more appropriate than keeping the limits in two contracts in sync.

L-19

MissingNonce Increment in `addNodeOperator` Function

**Severity**

Low

**Status**

Acknowledged

## Description

The issue is identified within the function `NodeOperatorsRegistry.sol#L317-L337` of the contract `NodeOperatorRegistry`. The current implementation does not increment the nonce within the `addNodeOperator` function, which is inconsistent with the behavior in related functions such as `activateNodeOperator` and `deactivateNodeOperator`. Although this omission does not impact the `obtainDepositData` function directly, it may lead to future issues with state tracking.

## Recommendation

We recommend adding a nonce increment within the `addNodeOperator` function to ensure consistency across the contract and to prevent potential issues related to state tracking.

## Client's Commentary

not issue

According to the description of the `getNonce()` method, its value should change only as a result of actions that modify the state of keys in the module. Adding an operator does not fall under such actions. See: `NodeOperatorsRegistry.sol#L1386`

L-20	Potential Issue with Signature Verification in <code>pauseDeposits</code> Function
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `DepositSecurityModule.sol#L384` function of the contract `DepositSecurityModule`. The current implementation of the function relies on the `ECDSA.recover` method to verify the signature provided by the guardian. However, there is a very low probability that the `recover` function can return a random address if the signature is invalid, potentially allowing the check to pass unexpectedly. This could result in unauthorized parties influencing the decision to pause deposits, which could pose a security risk.

## Recommendation

We recommend adding an index to the message that is signed by the guardian. This will ensure that each guardian's approval is uniquely identifiable and prevent the possibility of an invalid signature inadvertently passing the check.

## Client's Commentary

The `ECDSA.recover` method eliminates the risk of signature reuse by recalculating it from the upper range of the elliptic curve. Additionally, it ensures that invalid `s`, `r`, or `v` values can't result in a zero address being returned, as can happen with EVM's `ecrecover`, thus guaranteeing signature validity. The method also receives the hash of the message, which includes a prefix and block number, but restricted range of valid block numbers limiting the potential for message manipulation and craft alternative signatures that recover to the same valid address. Since the recovered address must be present in the contract's internal storage, the chance of randomly guessing a valid address is reduced to the extremely low probability of guessing a guardian's private key – an acceptable risk in practice within the crypto industry.

Therefore, adding the guardian index to the hashed message seems redundant.

L-21	Missing Validation of <code>depositCalldata</code> in <code>depositBufferedEther</code> Function
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `DepositSecurityModule.sol#L500` function of the contract `DepositSecurityModule`. The `depositCalldata` parameter is not included in the guardian signatures' validation process. Although `depositCalldata` is not currently used within staking modules, this omission could lead to potential security risks or inconsistencies in future implementations where `depositCalldata` might be utilized. An unchecked `depositCalldata` could allow unintended or malicious data to be processed, compromising the integrity of the deposit process.

## Recommendation

We recommend either verifying that `depositCalldata` is empty within the current implementation or incorporating it into the message hash that is signed by the guardians. This will ensure that any future use of `depositCalldata` is secure and validated by the guardian signatures.

## Client's Commentary

In the current design, the `depositCalldata` argument is the data might be necessary to prepare the deposit data by the staking module. Depending on the staking module implementation, it might be empty (`NodeOperatorsRegistry`) or contain complete deposit data (hypothetical staking module implementation that uses offchain storage for the deposit data). But for any staking module, the following is ALWAYS true: passed `depositCalldata` MUST NOT affect the deposit data set of the staking module. This requirement is explicitly defined in the comments of `IStakingModule.obtainDepositData()` method. In other words, call of `StakingModule.obtainDepositData()` with different valid `depositCalldata` for the same `StakingModule.nonce` leads to the same unambiguous set of deposited validators. For example, the offchain staking module might store a hash of the expected `depositCalldata` onchain to validate it and reject any call with unexpected `depositCalldata`.

L-22	Potential Rounding Errors in <code>_getDepositsAllocation</code> Function
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `StakingRouter.sol#L1424` function of the contract `StakingRouter`. The current implementation could lead to rounding errors when calculating the allocation of deposits among staking modules. Specifically, the sum of capacities minus the sum of allocations may be less than the total deposits to allocate (`_depositsToAllocate`), which could result in some staking modules not receiving their full allocation of validators. This could cause inefficiencies or under-utilization of available validators.

## Recommendation

We recommend accumulating any remaining "dust" (i.e., small amounts resulting from rounding errors) and assigning it to one of the staking modules. This will ensure that the total number of validators allocated matches the expected amount, maximizing the use of available validators.

## Client's Commentary

The stake distribution logic enforces that a module's share doesn't exceed its `stakeShareLimit`. Since stake allocation is always an integer, determining the number of active validator keys, accounting for fractional "dust" at the end of the cycle will also yield an integer. This leftover stake may need to be allocated to a module, potentially exceeding its `stakeShareLimit`, or additional logic would be required to find a module with sufficient key reserve and stake capacity. Adding such logic increases complexity and gas costs, making deposit operations more expensive.

L-23

Lack of Index Validation in `at` Function

**Severity**

Low

**Status**

Acknowledged

## Description

The issue is identified within the `QueueLib.sol#L229-L234` function of the `QueueLib` library. The function currently does not validate whether the provided `index` falls within the allowable range between `head` and `tail`. This could result in the function returning incorrect data or even accessing uninitialized memory, leading to unpredictable behavior.

## Recommendation

We recommend adding a check to ensure that the `index` falls within the range between `self.head` and `self.tail`. This will prevent out-of-bounds access and ensure that the function only returns valid data.

## Client's Commentary

The ability to get old items is crucial for the historical purposes. Items with indexes higher than head should be 0, and it is assumed that requested indexes are validated off-chain or on the integration side.

L-24

Missing Checks for `_pauseIntentValidityPeriodBlocks` and  
`_maxOperatorsPerUnvetting` Values

**Severity** Low

**Status** Acknowledged

### Description

The issue is identified within the [DepositSecurityModule.sol#L108](#). There are two parameters, `_pauseIntentValidityPeriodBlocks` and `_maxOperatorsPerUnvetting` passed. These parameters are not checked for the maximum values.

The issue is classified as **Low** severity because it may lead to incorrect contract configuration.

### Recommendation

We recommend adding checks to the functions `_setPauseIntentValidityPeriodBlocks` and `_setMaxOperatorsPerUnvetting` to ensure that the mentioned parameter values don't exceed acceptable boundaries.

### Client's commentary

No issue: All variables passed to the constructor will be double-checked before and after deployment manually and via acceptance tests. In case of wrong parameters passed, there is always an option to redeploy a contract with correct values.

L-25	Unnecessary Inheritance
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the `CSFeeOracle.sol#L17`. `CSFeeOracle` contract inherits both from `AssetRecoverer` contract and `IAssetRecovererLib` interface, but `AssetRecoverer` contract already implements `IAssetRecovererLib` and there is no need for `CSFeeOracle` to follow the same interface.

## Recommendation

We recommend removing unnecessary inheritance from the `IAssetRecovererLib` interface.

## Client's commentary

`IAssetRecovererLib` encapsulate events and errors definitions. `CSFeeOracle` inherits `IAssetRecovererLib` to make sure the ABI for the contract contains all the errors and events from the interface. Other contracts with recovery functionality use inheritance on their interfaces level.

L-26	Incorrect Comment
Severity	Low
Status	Fixed in cdc6e335

## Description

The issue is identified within the [BaseOracle.sol#L268](#) of the contract [BaseOracle](#). There are duplicate list numbers in the comment and info about the check for report processing deadline, but it is not implemented.

The issue is classified as **Low** severity because this missing check doesn't affect contract functionality.

## Recommendation

We recommend fixing the mentioned comment and removing info about the deadline check.

## Client's commentary

Fixed via [PR-331](#)

L-27	Possible Multiple Signature Usage in <code>DepositSecurityModule.depositBufferedEther()</code>
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

In certain cases, it is possible to use the same signature to invoke `DepositSecurityModule.sol#L494-L523` without a revert more than once. This can happen if the following conditions are met:

1. The amount of buffered ETH in Lido was 0 during the first invocation.
2. The `depositRoot` did not change during the `minDepositBlockDistance` blocks.

`DepositSecurityModule.depositBufferedEther()` is permissionless (in case of the correct set of signatures), so it may be a problem.

## Recommendation

We recommend reverting the `DepositSecurityModule.depositBufferedEther()` call if there is no buffered ETH at the moment of invocation.

## Client's commentary

It is assumed that a quorum of signatures confirms that the state of the deposit contract and module is checked and it is safe to perform a deposit to the module keys. Expectedly, if the module key state or the `deposit_root` have not changed, the signature remains valid. In case of an empty buffer, deposits do not pass and the signature is not invalidated.

Since the first version of DSM, there has indeed been a scenario to call the deposit method for an empty buffer. We have left it unchanged to maintain backward compatibility with off-chain tooling.

L-28	Lack of <code>genesisTime</code> Check in <code>HashConsensus</code> and <code>BaseOracle</code> Constructors
Severity	Low
Status	Acknowledged

## Description

The constructors of `HashConsensus` ([HashConsensus.sol#L240-L265](#), [HashConsensus.sol#L269-L299](#)) and `BaseOracle` ([BaseOracle.sol#L103-L107](#), [BaseOracle.sol#L129-L133](#)) lack a validation check to ensure that `genesisTime` is less than or equal to `block.timestamp`. This omission could allow incorrect values for the `genesisTime` parameter to be passed during the deployment.

## Recommendation

We recommend adding checks in the `HashConsensus` and `BaseOracle` constructors to ensure that `genesisTime` is less than or equal to `block.timestamp`.

## Client's commentary

`genesisTime` is a critical parameter checked both by off-chain oracles and post-deployment/acceptance tests. Therefore we do not see the need for an additional check of this parameter in the constructors.

L-29	Missing Proof Length Check in <code>getFeesToDistribute</code> Function
<b>Severity</b>	Low
<b>Status</b>	Fixed in <code>cdc6e335</code>

## Description

The issue is identified within the `CSFeeDistributor.sol#L175-L179` function of the contract `CSFeeDistributor`. The function currently does not validate the length of the Merkle proof provided in the `proof` parameter. As a result, there is a possibility that an empty or malformed proof could be passed, potentially allowing a user to craft a situation where they extract stETH shares without proper verification. This could lead to an unauthorized distribution of funds.

The issue is classified as **Low** severity because it requires to find shares amount that will generate a valid Merkle root. However, ensuring that the proof length is checked adds an extra layer of security to prevent potential exploits.

## Recommendation

We recommend adding a check to validate the length of the Merkle proof before verifying it.

## Client's commentary

Fixed in `PR-332`

L-30	Chain Id Value is Used in the <code>DepositSecurityModule</code> Constructor
<b>Severity</b>	Low
<b>Status</b>	Acknowledged

## Description

The issue is identified within the constructor of the contract `DepositSecurityModule`. The immutable variables `ATTEST_MESSAGE_PREFIX`, `PAUSE_MESSAGE_PREFIX`, and `UNVET_MESSAGE_PREFIX` values are calculated using `block.chainid`. There is a possibility of the chain id value changing due to potential modifications in the Ethereum chain. This may lead to replay attacks using signatures with the mentioned message prefixes.

The issue is classified as **Low** severity because it is unlikely that the chain id would change, and it is still better to follow EIP-712 domainSeparator calculation.

## Recommendation

We recommend calculating the `ATTEST_MESSAGE_PREFIX`, `PAUSE_MESSAGE_PREFIX`, and `UNVET_MESSAGE_PREFIX` message prefixes at the time when the message hash is calculated. This will ensure the use of the actual chain id.

## Client's commentary

This is indeed an extremely unlikely event, but in case it happens, it is assumed that the dev team will have enough time to prepare a deployment of the new DSM contract and switch to it, or initiate a deposit pause to mitigate a possible attack

L-31	Missing Nonce Increment in <code>_updateRefundValidatorsKeysCount</code> Function
<b>Severity</b>	Low
<b>Status</b>	Fixed in 1ffbb7e4

## Description

The issue is identified within the `NodeOperatorsRegistry.sol#L744-L766` function of the contract `NodeOperatorsRegistry`. The current implementation lacks a call to the `_increaseValidatorsNonce()` function when the `REFUNDED_VALIDATORS_COUNT_OFFSET` variable is modified. This is particularly important because the `REFUNDED_VALIDATORS_COUNT_OFFSET` variable can decrease, and failing to update the nonce could lead to discrepancies in the contract's state, affecting other functionalities that depend on accurate nonce tracking of depositable validators' updates.

The issue is classified as **Low** severity because it could result in inconsistencies in the contract's state, potentially affecting the integrity of validator key management and related operations.

## Recommendation

We recommend adding a call to the `_increaseValidatorsNonce()` function after updating the `REFUNDED_VALIDATORS_COUNT_OFFSET` variable to ensure that all state changes are properly tracked and the nonce remains consistent.

### 3. ABOUT MIXBYTES

MixBytes is a team of blockchain developers, auditors and analysts keen on decentralized systems. We build opensource solutions, smart contracts and blockchain protocols, perform security audits, work on benchmarking and software testing solutions, do research and tech consultancy.

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