

H.1. **Gas Cost.** The general gas cost function, C , is defined as:

$$(324) \quad C(\sigma, \mu, A, I) \equiv C_{\text{mem}}(\mu'_i) - C_{\text{mem}}(\mu_i) + \begin{cases} C_{\text{SSTORE}}(\sigma, \mu, A, I) & \text{if } w = \text{SSTORE} \\ G_{\text{exp}} & \text{if } w = \text{EXP} \wedge \mu_s[1] = 0 \\ G_{\text{exp}} + G_{\text{expbyte}} \times (1 + \lfloor \log_{256}(\mu_s[1]) \rfloor) & \text{if } w = \text{EXP} \wedge \mu_s[1] > 0 \\ G_{\text{verylow}} + G_{\text{copy}} \times \lceil \mu_s[2] \div 32 \rceil & \text{if } w \in W_{\text{copy}} \\ C_{\text{aaccess}}(\mu_s[0] \bmod 2^{160}, A) + G_{\text{copy}} \times \lceil \mu_s[3] \div 32 \rceil & \text{if } w = \text{EXTCODECOPY} \\ C_{\text{aaccess}}(\mu_s[0] \bmod 2^{160}, A) & \text{if } w \in W_{\text{extaccount}} \\ G_{\text{log}} + G_{\text{logdata}} \times \mu_s[1] & \text{if } w = \text{LOG0} \\ G_{\text{log}} + G_{\text{logdata}} \times \mu_s[1] + G_{\text{logtopic}} & \text{if } w = \text{LOG1} \\ G_{\text{log}} + G_{\text{logdata}} \times \mu_s[1] + 2G_{\text{logtopic}} & \text{if } w = \text{LOG2} \\ G_{\text{log}} + G_{\text{logdata}} \times \mu_s[1] + 3G_{\text{logtopic}} & \text{if } w = \text{LOG3} \\ G_{\text{log}} + G_{\text{logdata}} \times \mu_s[1] + 4G_{\text{logtopic}} & \text{if } w = \text{LOG4} \\ C_{\text{CALL}}(\sigma, \mu, A) & \text{if } w \in W_{\text{call}} \\ C_{\text{SELFDESTRUCT}}(\sigma, \mu) & \text{if } w = \text{SELFDESTRUCT} \\ G_{\text{create}} & \text{if } w = \text{CREATE} \\ G_{\text{create}} + G_{\text{keccak256word}} \times \lceil \mu_s[2] \div 32 \rceil & \text{if } w = \text{CREATE2} \\ G_{\text{keccak256}} + G_{\text{keccak256word}} \times \lceil \mu_s[1] \div 32 \rceil & \text{if } w = \text{KECCAK256} \\ G_{\text{jumpdest}} & \text{if } w = \text{JUMPDEST} \\ C_{\text{SLOAD}}(\mu, A, I) & \text{if } w = \text{SLOAD} \\ G_{\text{zero}} & \text{if } w \in W_{\text{zero}} \\ G_{\text{base}} & \text{if } w \in W_{\text{base}} \\ G_{\text{verylow}} & \text{if } w \in W_{\text{verylow}} \\ G_{\text{low}} & \text{if } w \in W_{\text{low}} \\ G_{\text{mid}} & \text{if } w \in W_{\text{mid}} \\ G_{\text{high}} & \text{if } w \in W_{\text{high}} \\ G_{\text{blockhash}} & \text{if } w = \text{BLOCKHASH} \end{cases}$$

$$(325) \quad w \equiv \begin{cases} I_b[\mu_{\text{pc}}] & \text{if } \mu_{\text{pc}} < \|I_b\| \\ \text{STOP} & \text{otherwise} \end{cases}$$

where:

$$(326) \quad C_{\text{mem}}(a) \equiv G_{\text{memory}} \cdot a + \left\lfloor \frac{a^2}{512} \right\rfloor$$

$$(327) \quad C_{\text{aaccess}}(x, A) \equiv \begin{cases} G_{\text{warmaccess}} & \text{if } x \in A_{\mathbf{a}} \\ G_{\text{coldaccountaccess}} & \text{otherwise} \end{cases}$$

with C_{CALL} , $C_{\text{SELFDESTRUCT}}$, C_{SLOAD} and C_{SSTORE} as specified in the appropriate section below. We define the following subsets of instructions:

$$W_{\text{zero}} = \{\text{STOP, RETURN, REVERT}\}$$

$$W_{\text{base}} = \{\text{ADDRESS, ORIGIN, CALLER, CALLVALUE, CALLDATASIZE, CODESIZE, GASPRICE, COINBASE, TIMESTAMP, NUMBER, DIFFICULTY, GASLIMIT, CHAINID, RETURNDATASIZE, POP, PC, MSIZE, GAS}\}$$

$$W_{\text{verylow}} = \{\text{ADD, SUB, NOT, LT, GT, SLT, SGT, EQ, ISZERO, AND, OR, XOR, BYTE, SHL, SHR, SAR, CALLDATALOAD, MLOAD, MSTORE, MSTORE8, PUSH*, DUP*, SWAP*}\}$$

$$W_{\text{low}} = \{\text{MUL, DIV, SDIV, MOD, SMOD, SIGNEXTEND, SELFBALANCE}\}$$

$$W_{\text{mid}} = \{\text{ADDMOD, MULMOD, JUMP}\}$$

$$W_{\text{high}} = \{\text{JUMPI}\}$$

$$W_{\text{copy}} = \{\text{CALLDATACOPY, CODECOPY, RETURNDATACOPY}\}$$

$$W_{\text{call}} = \{\text{CALL, CALLCODE, DELEGATECALL, STATICCALL}\}$$

$$W_{\text{extaccount}} = \{\text{BALANCE, EXTCODESIZE, EXTCODEHASH}\}$$

Note the memory cost component, given as the product of G_{memory} and the maximum of 0 & the ceiling of the number of words in size that the memory must be over the current number of words, μ_i in order that all accesses reference valid memory whether for read or write. Such accesses must be for non-zero number of bytes.

Referencing a zero length range (e.g. by attempting to pass it as the input range to a CALL) does not require memory to be extended to the beginning of the range. μ'_i is defined as this new maximum number of words of active memory; special-cases are given where these two are not equal.