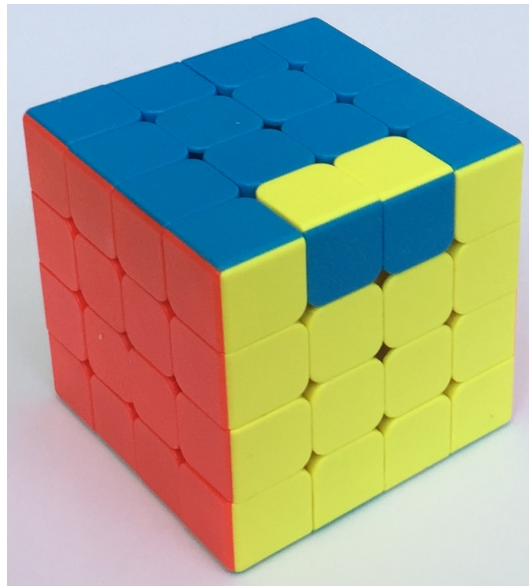


Rubik's Revenge edge processes

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Introduction



Rubik's Revenge is like Rubik's cube except where it obviously differs. Look at the picture. We assume you are familiar with the way it works and the basic problem to be solved.

Our main purpose is to examine in some detail certain types of Rubik's Revenge edge processes.

First, we introduce some notation based on David Singmaster's *Notes*, [1]. Upper-case letters

U, D, F, B, L and R

denote either the faces or the outer slices of the cube: up, down, front, back, left and right, respectively. Lower-case letters

u, d, f, b, l and r

denote the inner slices adjacent to outer slices U, D, F, B, L and R , respectively.

A single piece of the cube is denoted by the letters of the three slices that intersect it. For example: UFL is the piece in the up-front-left corner, UFl refers to the edge piece on the left of the up-front edge, and Ufl refers to the front-left face centre piece of the up face. The same notation is also used for positions.

Face centre pieces can be permuted amongst themselves in $24!$ ways. Edge pieces can be permuted amongst themselves in $24!$ ways, but unlike Rubik's cube edges they cannot be flipped. A corner piece in its correct position can have three distinct orientations; it might be correctly orientated, or twisted 120° clockwise, or twisted 120° anticlockwise.

Each of the symbols $\{U, D, F, B, L, R, u, d, f, b, l, r\}$ is also used to denote a 90° clockwise turn of the cube slice of that name. Multiple turns are indicated by exponents, and we usually write X' for X^{-1} . For example, F^2 means turn the F outer slice through 180° , and u' means turn the u slice 90° anticlockwise.

The inverse, $\mathcal{P}' = \mathcal{P}^{-1}$, of a sequence of moves \mathcal{P} is the sequence of inverses of the moves of \mathcal{P} but in the reverse order. Given two sequences of moves \mathcal{P} and \mathcal{Q} , the *conjugate* $(\mathcal{P}, \mathcal{Q})$ and *commutator* $[\mathcal{P}, \mathcal{Q}]$ are defined by

$$(\mathcal{P}, \mathcal{Q}) = \mathcal{P}\mathcal{Q}\mathcal{P}', \quad [\mathcal{P}, \mathcal{Q}] = \mathcal{P}\mathcal{Q}\mathcal{P}'\mathcal{Q}'.$$

Observe that $(\mathcal{P}, \mathcal{Q})' = (\mathcal{P}', \mathcal{Q}')$ and $[\mathcal{P}, \mathcal{Q}]' = [\mathcal{Q}, \mathcal{P}]$.

Incidentally, our concepts of 'positive rotation', 'conjugate' and 'commutator' are consistent with the definitions in [1]. It is mildly unfortunate that they deviate from mainstream Mathematics.

We measure sequences by the number of moves they contain, where we count any non-trivial power of a slice turn as a single move. So, for instance, the '2-flip' sequence $l^2 B^2 [l', U^2] B^2 l B^2 [r', U^2] B^2 l^2$ has 15 moves.

Assuming the cube has a fixed orientation in space and the face centre pieces are distinct, the number of achievable permutations is

$$\frac{24! \cdot 24! \cdot 3^8 \cdot 8!}{3}.$$

The 3 in the denominator is there because corner twists must sum to $0 \pmod{3}$. Divide by $(4!)^6$ if face centre pieces of the same colour are indistinguishable. Divide by 24, the order of the rotational symmetry group of the cube, if the orientation of the whole cube is not fixed.

Rubik's Revenge edge processes

We are interested in Rubik's Revenge processes of the form

$$\begin{aligned} & [[\mathcal{W}, \mathcal{X}], \mathcal{Y}], \\ & \mathcal{W} = W_1 W_2 \dots W_p, \quad W_i \in \{F, B, L, R, U, D\}, \quad i = 1, 2, \dots, p, \\ & \mathcal{X} = X_1 X_2 \dots X_q, \quad X_i \in \{F, B, L, R, U, D\}, \quad i = 1, 2, \dots, q, \\ & \mathcal{Y} = Y_1 Y_2 \dots Y_r, \quad Y_j \in \{f, b, l, r, u, d\}, \quad j = 1, 2, \dots, r. \end{aligned} \quad (1)$$

The commutator $[\mathcal{W}, \mathcal{X}]$ leaves face centre pieces fixed. Therefore any face centre pieces moved by \mathcal{Y} will be unmoved by \mathcal{Y}' . Furthermore, corner pieces moved by $[\mathcal{W}, \mathcal{X}]$ are not affected by \mathcal{Y} and will get restored by $[\mathcal{W}, \mathcal{X}]'$. Therefore $[[\mathcal{W}, \mathcal{X}], \mathcal{Y}]$ moves only edges; it is an edge process.

The action of the inner slice turns on the 24 edge pieces partitions them into 6 sets of 4. That is, each element of $I = \{f, b, l, r, u, d\}$ acts on its own set of 4 edge pieces, which are unaffected by the other members of I . This means that inner slice turns act commutatively on edge pieces. Hence the order of the moves in \mathcal{Y} does not affect the result of $[[\mathcal{W}, \mathcal{X}], \mathcal{Y}]$. Therefore we may assume $\mathcal{Y} = f^{e_1} b^{e_2} l^{e_3} r^{e_4} u^{e_5} d^{e_6}$, $e_1, e_2, \dots, e_6 \in \{0, 1, 2, 3\}$.

The *cycle pattern* of an edge process \mathcal{E} is the collection of lengths of the disjoint cycles of the permutation of edge pieces moved by \mathcal{E} .

Although odd permutations of edge pieces are permitted generally, only even permutations can be achieved by processes of the form $[[\mathcal{W}, \mathcal{X}], \mathcal{Y}]$. A commutator always involves an even number of slice turns.

The first few cycle patterns are

$$\begin{aligned} & (3), \quad (2,2), \quad (5), \quad (2,4), (3,3), \quad (7), (2,2,3), \\ & (2,6), (3,5), (4,4), (2,2,2,2), \\ & (9), (2,2,5), (2,3,4), (3,3,3), \\ & (2,8), (3,7), (4,6), (5,5), (2,2,2,4), (2,2,3,3), \\ & (11), (2,2,7), (2,3,6), (2,4,5), (3,3,5), (3,4,4), (2,2,2,2,3), \\ & (2,10), (3,9), (4,8), (5,7), (6,6), (2,2,2,6), (2,2,3,5), (2,2,4,4), \\ & (2,3,3,4), (3,3,3,3), (2,2,2,2,2,2), \dots \end{aligned}$$

and the last one is $(2,2,2,2,2,2,2,2,2,2,2,2)$. The tables show the numbers of possible cycle patterns: by number of cycles, ...

1	2	3	4	5	6	7	8	9	10	11	12		
11	66	126	200	141	132	54	41	11	8	1	1		792

... by number of moves in the edge processes $[[\mathcal{W}, \mathcal{X}], \mathcal{Y}]$ sufficient to achieve

the patterns, ...

10	12	14	16	18	20	22	24	26	28	30	32	
3	6	5	18	46	62	140	253	189	62	3	5	792

... and by number of edge pieces moved.

1	2	3	4	5	6	7	8	9	10	11	12	
0	0	1	1	1	2	2	4	4	6	7	11	
13	14	15	16	17	18	19	20	21	22	23	24	
12	17	21	28	33	44	53	69	83	105	127	161	792

The figure for column p in the last table is the number of partitions of p into integer parts greater than 1 where the number of even parts is even. The number of parts has the same parity as p .

There is probably nothing special about the term $[\mathcal{W}, \mathcal{X}]$ in (1). What we want to do is create an edge process by commutating a sequence of face turns with a sequence of inner slice turns. This will work if the face turns avoid rotating the face centres. A possible alternative is to do the face turns as \mathcal{X}^4 ; nice and simple but it has the disadvantage of producing longer sequences. Or perhaps we could just allow any sequence of face turns where the exponents sum to 0 modulo 4 for each of the 6 faces. Anyway, $[\mathcal{W}, \mathcal{X}]$ works—in the sense that it is easy to find short sequences of the form $[[\mathcal{W}, \mathcal{X}], \mathcal{Y}]$ for all 792 cycle patterns.

There now follows a catalogue of the 792 edge process cycle patterns together with examples of sequences of at most 32 moves that achieve them. First we list a few of the more interesting ones, then the whole lot.

$[[F, R], d]$ (10 moves): (FU_r FR_d LF_d) 3s.

$[[FB, R], r^2]$ (14 moves): (FU_r BDr)(RU_f RD_b) 2s 2s.

$[[F^2, R^2], ud]$ (12 moves): (FL_u BR_u)(FR_u BR_d)(FL_d BL_u)(FR_d BL_d) 2s 2s 2s.

$[[F, R], brud]$ (16 moves): (FU_l FR_u RBU)(FU_r FR_d DR_b)(FL_d FD_r DL_b) 3s 3s 3s.

$[[F, R^2], lru^2d^2]$ (16 moves): (FU_l FR_u BR_d)(FU_r FR_d BR_u)(FL_u BL_d DFr)(FL_d BL_u UB_l) 3s 3s 3s.

$[[FB, R^2], ru^2d^2]$ (18 moves): (FU_r BDr)(FL_u BLd)(FR_u BRd)(FLd BL_u)(FRd BR_u)(FD_r BU_r) 2s 2s 2s 2s 2s 2s.

$[[FB, R], b^2ud^2]$ (18 moves): (FU_l FR_u RB_u BL_u DBr)(FU_r FRd DRb ULb BLd)(FLd BDI BRd URb DLb) 5s 5s 5s.

$[[FB, R], blrd]$ (20 moves): (FU_l UBI DRf)(FU_r FDI DRb)(FLd FDr DLb)(BU_r RUf DBr)(BRd URb BDI) 3s 3s 3s 3s 3s.

$[[F^2B^2, R], f^2b^2d^2]$ (18 moves): (FL_u DLf BR_u URf)(FR_u DRf BL_u ULf)(FLd BRd URb DLb)(FRd DRb ULb BLd) 4s 4s 4s 4s.

$[[FB, R^2], lru^2d^2]$ (20 moves): (FU_l BDI)(FU_r BDr)(FL_u BLd)(FR_u BRd)(FLd BL_u)(FRd BR_u)(FDI BU_l)(FD_r BU_r) 2s 2s 2s 2s 2s 2s 2s 2s.

$[[FB, R], b^2lrd^2]$ (20 moves): (FU_l UBI DRf)(FU_r FRd DRb)(FLd DF_l DLb)(FD_r LU_b LBd)(BU_r RUf DBr)(BRd URb BDI) 3s 3s 3s 3s 3s 3s.

$[[FB, R], lru^2d^2]$ (20 moves): (FU_l FR_u BL_u UBI DRf)(FU_r FRd BLd DFr DRb)(FL_u UBr URf BDr BR_u)(FLd DF_l URb BDI BRd) 5s 5s 5s 5s.

$[[FR^2, D^2B'], fblr^2]$ (24 moves): (FU_l UBI)(FU_r BDr)(FR_u BRd)(FRd UBr)(FDI DBI)(FD_r RB_u)(LU_b RUf)(LUf RDf)(LD_b RU_b)(LDf RD_b) 2s 2s 2s 2s 2s 2s 2s 2s 2s.

$[[FB^2, RU], blud']$ (24 moves): (FU_l RDb UBI BDI DF_l URb FLd)(FU_r URf FL_u RF_u BR_u LB_u RDf)(FRd BLd LD_b RBd UBr ULb BDr) 7s 7s 7s.

$[[FB, R], fb^2lrud^2]$ (24 moves): (FU_l FR_u DRf)(FU_r FRd DRb)(FLd DF_l DLb)(FD_r LU_b LBd)(BU_r ULf BL_u)(BU_l URf BDr)(BRd URb BDI) 3s 3s 3s 3s 3s 3s.

$[[FB, L^2R], f^2b^2lrd^2]$ (26 moves): (FU_l UBI DLb FLd BRd URb)(FU_r FL_u DFr DLf BR_u URf)(FR_u DRf BDI BL_u DF_l ULf)(FRd DRb BDr UBr ULb BLd) 6s 6s 6s 6s.

$[[FR^2, U^2D^2], br^2u^2d^2]$ (24 moves): (FU_l BL_u BDI FR_u)(FU_r BDr FRd BLd)(FL_u FDI BR_u BU_l)(FLd BRd FDr BU_r)(LU_b URb RDb DLb)(LUf URf RDf DLf) 4s 4s 4s 4s 4s 4s.

$[[FB, R], f^2b^2lru^2d^2]$ (24 moves): (FU_l FR_u DRf)(FU_r FRd DRb)(FL_u UBr DLf)(FLd DF_l DLb)(FD_r LU_b LBd)(BU_l LUf LB_u)(BR_u URf BDr)(BRd URb BDI) 3s 3s 3s 3s 3s 3s 3s.

$[[FB, LR], l^2r^2u^2d^2]$ (24 moves): (FU_l FDr)(FU_r FDI)(FL_u BR_u)(FR_u BL_u)(FLd BRd)(FRd BLd)(BU_r BDI)(BU_l BDr)(LU_b LDf)(LUf LD_b)(RUf RDb)(RU_b RDf) 2s 2s 2s 2s 2s 2s 2s 2s 2s 2s 2s.

3 edge pieces, 1 cycle

$[[F, R], d]$ (10 moves): (FUr FRd LFd) 3s.

4 edge pieces, 2 cycles

$[[FB, R], r^2]$ (14 moves): (FUr BDr)(RUf RDb) 2s 2s.

5 edge pieces, 1 cycle

$[[F, R^2], d]$ (10 moves): (FUr RFu RBd FRd LFd) 5s.

6 edge pieces, 2 cycles

$[[FRF, U], r]$ (18 moves): (FUr FDI URf UBr)(FDr DBr) 4s 2s.

$[[F, R^2], d^2]$ (10 moves): (FUr FRd BLd)(FRu BRd FLd) 3s 3s.

7 edge pieces, 1 cycle

$[[F, R^2], rd]$ (12 moves): (FUr RFu RBd FRd LFd DFr BRu) 7s.

7 edge pieces, 3 cycles

$[[FB^2, R], d^2]$ (14 moves): (FUr URf)(FLd BLu BRd)(FRd BLd) 2s 3s 2s.

8 edge pieces, 2 cycles

$[[FB, R], r^2d]$ (16 moves): (FUr DBl RBd FRd LFd BDr)(RUf RDb) 6s 2s.

$[[F, R^2], rd^2]$ (12 moves): (FUr FRd BLd DFr BRu)(FRu BRd FLd) 5s 3s.

$[[F, R^2], ud]$ (12 moves): (FUl FRu BRd RFd)(FUr BRu LBU LFd) 4s 4s.

8 edge pieces, 4 cycles

$[[F^2, R^2], ud]$ (12 moves): (FLu BRu)(FRu BRd)(FLd BLu)(FRd BLd) 2s 2s 2s.

9 edge pieces, 1 cycle

$[[F, R^2], ud^2]$ (12 moves): (FUl FRu BRd FLd RBu BLu LBd UFr RFd) 9s.

9 edge pieces, 3 cycles

$[[FB, R^2], rd]$ (16 moves): (FUr BDr)(FRu BRd RFd FLd RBu)(FDr BUr)

2s 5s 2s.

$[[F, R^2], rud]$ (14 moves): (FUl FRu BRd RFd)(FUr BRu)(FLd FDr BLu)
4s 2s 3s.

$[[F, R], brud]$ (16 moves): (FUl FRu RBu)(FUr FRd DRb)(FLd FDr DLb)
3s 3s 3s.

10 edge pieces, 2 cycles

$[[FB^2, R], bd^2]$ (16 moves): (FUr URf)(FLd BLu BRd URb RDb DLb LBd
RFd) 2s 8s.

$[[F, R^2], rud^2]$ (14 moves): (FUl FRu BRd FLd RBu UFr RFd)(FDr BLu
LBd) 7s 3s.

$[[FB^2, R], bd']$ (16 moves): (FUr FRd BLd LFd URf LBU)(BRd URb RDb
DLb) 6s 4s.

$[[F, R^2], u^2d^2]$ (12 moves): (FUl FRu BRd FLd BLu)(FUr FRd BRu FLu
BLd) 5s 5s.

10 edge pieces, 4 cycles

$[[FL^2R^2, U], b^2d]$ (20 moves): (FUr FLu)(FLd LBd LUb RDb)(BUr
LDf)(LDb RUB) 2s 4s 2s 2s.

$[[F, R^2], lrud]$ (16 moves): (FUl FRu BRd)(FUr BRu)(FLd FDr BLu)(FRd
BUl) 3s 2s 3s 2s.

11 edge pieces, 1 cycle

$[[FB^2, R], bu]$ (16 moves): (FUl FRu RBu BLu LFu RDb DLb RFd BRd
URb LBd) 11s.

11 edge pieces, 3 cycles

$[[F^2B^2, R], bd^2]$ (16 moves): (FLu URf)(FLd BRd URb RDb DLb LBd
RFd)(BLu DRf) 2s 7s 2s.

$[[FB^2, R], bu^2]$ (16 moves): (FUl RDb DLb RFd BRd URb)(FLu BLd
BRu)(FRu BLu) 6s 3s 2s.

$[[FB^2, R], b^2d^2]$ (16 moves): (FUr URf)(FLd BLu BRd URb DLb)(FRd
DRb ULb BLd) 2s 5s 4s.

$[[F, R^2], ru^2d^2]$ (14 moves): (FUl FRu BRd FLd BLu)(FUr FRd BRu)(FLu BLd DFr) 5s 3s 3s.

$[[F^2B^2, R], bd']$ (16 moves): (FLu Rdf URf LBu)(FLd RFd LBd)(BRd URb RDb DLb) 4s 3s 4s.

11 edge pieces, 5 cycles

$[[FB, R^2], rud^2]$ (18 moves): (FUr BDr)(FRu BRd)(FLd RBu RFd)(FDr BUr)(BLu LBd) 2s 2s 3s 2s 2s.

12 edge pieces, 2 cycles

$[[FB^2, R], ud^2]$ (16 moves): (FUl FRu RBu BLu BRd FLd LFu URb RFd LBd)(FUr URf) 10s 2s.

$[[FB^2, R], b^2u]$ (16 moves): (FUl FRu RBu BLu LFu DLb BRd URb LBd)(FRd DRb ULb) 9s 3s.

$[[FB^2, R], ud']$ (16 moves): (FUl FRu RBu BLu UFr RFd BRd LBd)(FLu RUb Lfd URf) 8s 4s.

$[[FB, R], bud]$ (18 moves): (FUl FRu RBu BLu DBr)(FUr DBl RBd RUb DRb LDb Lfd) 5s 7s.

$[[FB^2, R], ud]$ (16 moves): (FUl FRu RBu BLu RUf LBd)(FUr FLu RUb RBd FRd Lfd) 6s 6s.

12 edge pieces, 4 cycles

$[[FB^2R', D^2], br^2]$ (20 moves): (FUr DRb LDb ULb Rdf BDr)(FRu BDI)(FDl DLf)(FDr BUr) 6s 2s 2s 2s.

$[[FB', R^2], rud^2]$ (18 moves): (FUl BUr UFr FDr UBl)(FRu BRd)(FLd RBu RFd)(BLu LBd) 5s 2s 3s 2s.

$[[FB^2, R], u^2d^2]$ (16 moves): (FUl URb)(FUr URf)(FLu FRd BLd BRu)(FRu BLu BRd FLd) 2s 2s 4s 4s.

$[[FB^2, R], b^2u^2]$ (16 moves): (FUl DLb BRd URb)(FLu BLd BRu)(FRu BLu)(FRd DRb ULb) 4s 3s 2s 3s.

$[[F, R^2], lru^2d^2]$ (16 moves): (FUl FRu BRd)(FUr FRd BRu)(FLu BLd DFr)(FLd BLu UBl) 3s 3s 3s 3s.

12 edge pieces, 6 cycles

$[[FB, R^2], ru^2d^2]$ (18 moves): (FU_r BDr)(FL_u BLd)(FR_u BRd)(FLd BL_u)(FRd BR_u)(FDr BU_r) 2s 2s 2s 2s 2s 2s.

13 edge pieces, 1 cycle

$[[FB^2, R], bu^2d]$ (18 moves): (FU_l RDb DLb FLd UFr FR_u BL_u RUf LBd RB_u LF_u BRd URb) 13s.

13 edge pieces, 3 cycles

$[[FR, D], brud]$ (20 moves): (FR_u LDf)(FLd LU_b DFl BL_u RB_u RDb FDr DBr DLb)(FRd RBd) 2s 9s 2s.

$[[FB, R], r^2ud^2]$ (18 moves): (FU_l FR_u RB_u BL_u UFr RFd LBd DBr)(FLd BDI BRd)(RUf RDb) 8s 3s 2s.

$[[FR, D], b^2ud^2]$ (18 moves): (FR_u LDf)(FLd LBd URb DFl DLb RFd BRd)(BR_u DRb ULb LB_u) 2s 7s 4s.

$[[FB^2, R], bud]$ (18 moves): (FU_l FR_u RB_u BL_u RUf LBd)(FU_r FL_u DRb LD_b LF_d)(BRd URb) 6s 5s 2s.

$[[FB, R], bu^2d]$ (18 moves): (FU_l FR_u BL_u)(FU_r DBI RBd RU_b DRb LD_b LF_d)(FL_u BDr BR_u) 3s 7s 3s.

$[[FB, R], br^2u^2]$ (18 moves): (FU_l FR_u BL_u)(FU_r BDr BR_u FL_u)(FRd RBd RU_b DRb URf LD_b) 3s 4s 6s.

$[[FB^2, R], fb^2r]$ (18 moves): (FU_r DFr ULb FRd DRb)(FR_u DRf RUf ULf RB_u)(BRd URb DLb) 5s 5s 3s.

$[[FB, R], bud']$ (18 moves): (FU_l FR_u RB_u BL_u DBr)(FU_r FRd BLd DBI)(BRd URb RDb DLb) 5s 4s 4s.

13 edge pieces, 5 cycles

$[[FB, R^2], lrd]$ (18 moves): (FU_l BDI)(FU_r BDr)(FR_u BRd RFd FLd RB_u)(FDI BU_l)(FDr BU_r) 2s 2s 5s 2s 2s.

$[[FB^2R^2, U'], b^2r^2]$ (20 moves): (FU_l FLd)(FU_r BDr)(FDr BDI BU_r)(BU_l RU_b Rdf LD_b)(LU_b RDb) 2s 2s 3s 4s 2s.

$[[FB', R^2], r^2ud^2]$ (18 moves): (FU_l BU_r FDr)(FU_r BDr BU_l)(FR_u BRd)(FLd RB_u RFd)(BL_u LBd) 3s 3s 2s 3s 2s.

14 edge pieces, 2 cycles

$[[FB^2, R], ru^2d]$ (18 moves): (FUl URb)(FUr RFu LBU URf BLd BRu FLu RBd FRd LFd DFr DRb) 2s 12s.

$[[FB^2, R], b^2ld]$ (18 moves): (FUl UBl DRf)(FUr LBU URf BLd RBd RUB LDb FRd DRb ULb LFd) 3s 11s.

$[[FB^2, R], rud^2]$ (18 moves): (FUl FRu RBu BLu BRd FLd LFu URb RFd LBd)(FUr URf DFr DRb) 10s 4s.

$[[FB, R], bud^2]$ (18 moves): (FUl FRu RBu BLu DBr)(FUr FRd LFd DBl RBd RUB DRb LDb BLd) 5s 9s.

$[[FB^2, R], rud]$ (18 moves): (FUl FRu RBu BLu RUf LBd)(FUr FLu RUB RBd FRd LFd DFr DRb) 6s 8s.

$[[FB, R], rud]$ (18 moves): (FUl FRu RBu BLu BUr RUf DBr)(FUr DBl RBd FRd LFd DFr DRb) 7s 7s.

14 edge pieces, 4 cycles

$[[FB, R], l^2r^2ud']$ (20 moves): (FUl FRu RBu BLu UFr RFd BRd LBd)(BDr DBl)(RUf RDb)(RUB Rdf) 8s 2s 2s 2s.

$[[FBR^2, U], fb^2]$ (20 moves): (FUl RBu DRf RUf ULf Ldf UBl)(FUr RUB LDb)(BUr BRd)(LUB RDb) 7s 3s 2s 2s.

$[[FR, D], b^2rud]$ (20 moves): (FRu Ldf)(FLd URb Dfl DLb)(FRd RBd)(FDr DBr LUb BLu RBu RDb) 2s 4s 2s 6s.

$[[FB, R], l^2r^2ud]$ (20 moves): (FUl FRu RBu BLu UFr)(FLd DBr Bdl BRd RFd)(RUf RDb)(RUB Rdf) 5s 5s 2s 2s.

$[[FB, R], r^2u^2d^2]$ (18 moves): (FUl FRu BLu)(FUr FRd BLd BDr BRu FLu)(FLd Bdl BRd)(RUf RDb) 3s 6s 3s 2s.

$[[FB, R], lr^2d^2]$ (18 moves): (FUl UBl DRf)(FUr FRd BLd BDr)(FLd Dfl URb Bdl BRd)(RUf RDb) 3s 4s 5s 2s.

$[[FB^2, R], ru^2d^2]$ (18 moves): (FUl URb)(FUr URf DFr DRb)(FLu FRd BLd BRu)(FRu BLu BRd FLd) 2s 4s 4s 4s.

$[[FB, R], b^2rd^2]$ (18 moves): (FUr FRd DRb)(FLd Bdl BRd URb DLb)(FDr LUb LBd)(BUr RUf DBr) 3s 5s 3s 3s.

$[[FB, R], bu^2d']$ (18 moves): (FUl FRu BLu)(FUr FRd BLd DBl)(FLu BDr BRu)(BRd URb RDb DLb) 3s 4s 3s 4s.

14 edge pieces, 6 cycles

$[[FB^2, RU'], r^2d^2]$ (20 moves): (FUl LFu)(FUr BDr)(FLd BRd)(FRd BLd)(FDr BDI BUr RUf)(BLu LUb) 2s 2s 2s 2s 4s 2s.

$[[FB, R^2], lrd^2]$ (18 moves): (FUl BDI)(FUr BDr)(FRu BRd FLd)(FRd BLd BRu)(FDl BUl)(FDr BUr) 2s 2s 3s 3s 2s 2s.

15 edge pieces, 1 cycle

$[[FB^2, R], b^2ud']$ (18 moves): (FUl FRu RBu BLu UFr RFd RDb LUb BRd URb FLd RUf LFu DLb LBd) 15s.

15 edge pieces, 3 cycles

$[[FB, R], l^2r^2ud^2]$ (20 moves): (FUl FRu RBu BLu UFr RFd LBd DBr BDI BRd FLd)(RUf RDb)(RUB Rdf) 11s 2s 2s.

$[[FB^2, R], b^2ud^2]$ (18 moves): (FUl FRu RBu BLu BRd URb RFd RDb LUb LBd)(FUr URf)(FLu LDl LFd) 10s 2s 3s.

$[[FR', D^2], bl^2r^2]$ (18 moves): (FUl BDI)(FUr DRb LDl UBr RFu DFr ULb Rdf BDr)(FRd FDI DLf BUl) 2s 9s 4s.

$[[FB^2, R], blud]$ (20 moves): (FUl FRu RBu BLu RUf LBd UBl DRf)(FUr FLu DRb LDl LFd)(BRd URb) 8s 5s 2s.

$[[FB^2, R], b^2ud]$ (18 moves): (FUl FRu RBu BLu RUf LBd)(FUr FLu LDl BRd DRb ULb LFd)(BRd URb) 6s 7s 2s.

$[[FB, R], lrd]$ (18 moves): (FUl UBl DRf)(FUr FDI RUB DBl RBd FRd FLd DFr DRb)(BUr RUf DBr) 3s 9s 3s.

$[[FB^2, R], fb^2u^2]$ (18 moves): (FUl DLb BRd URb)(FLu BLd BRu LBu RFu Rdf URf LUf)(FRd DRb ULb) 4s 8s 3s.

$[[FB, R], rud^2]$ (18 moves): (FUl FRu RBu BLu BUr RUf DBr)(FUr FRd BLd DFr DRb)(FLd BDI BRd) 7s 5s 3s.

$[[F^2R^2, U], f^2b^2r]$ (18 moves): (FUl RUf BUr RDb DFl LDf)(FUr RUB LDl DFr BDr ULb)(BUl Rdf LUf) 6s 6s 3s.

$[[FR', D^2], blr']$ (18 moves): (FUl UBl LUb DRf BUr LDf FRu)(FUr DRb LDl FRd)(FDl BDr DFr DBl) 7s 4s 4s.

$[[FB^2, R], fb^2d^2]$ (18 moves): (FUr LUf BRu RFu Rdf URf)(FLd BLu BRd URb DLb)(FRd DRb ULb BLd) 6s 5s 4s.

$[[FB, R], b^2ud^2]$ (18 moves): (FUl FRu RBu BLu DBr)(FUr FRd DRb ULb BLd)(FLd BDI BRd URb DLb) 5s 5s 5s.

15 edge pieces, 5 cycles

$[[FR^2, U^2], fbrd]$ (20 moves): (FUl BUr FLd LBd UFr FDr LFu)(LUb RUf)(LUf Rdf)(LDb RUB)(Ldf RDb) 7s 2s 2s 2s 2s.

$[[FBR^2, U], fb^2u^2]$ (22 moves): (FUl LFu RBu DRf Ldf UBl)(FUr RUB LDb)(BUr BRd)(LUb RDb)(LUf URf) 6s 3s 2s 2s 2s.

$[[FB^2R', U], b^2r^2d]$ (22 moves): (FUr RUB LDb BDr)(FLu LUf)(FLd LBd)(FDr RUf BUr LUb RDb)(BRd BDI) 4s 2s 2s 5s 2s.

$[[FR, D], lrud^2]$ (20 moves): (FUl DRf DF1)(FRu Ldf)(FLd LBd DLb Rfd BRd)(FDr DBr RDb)(BRu LBu) 3s 2s 5s 3s 2s.

$[[FB', RU'], b^2u]$ (20 moves): (FUr BUl URf LUf)(FLu RFu BRu LBu)(FRd Rdf)(BRd URb DLb)(LUb RDb) 4s 4s 2s 3s 2s.

$[[FR, D^2], lrud^2]$ (20 moves): (FUl LBd BUr)(FRu FDr BDI)(FLd DLb BRd)(FRd BDr)(FDl BRu LBu DLf) 3s 3s 3s 2s 4s.

$[[FB, R], blrd]$ (20 moves): (FUl UBl DRf)(FUr FDI DRb)(FLd FDr DLb)(BUr RUf DBr)(BRd URb BDI) 3s 3s 3s 3s 3s.

15 edge pieces, 7 cycles

$[[FB, R^2], lrud^2]$ (20 moves): (FUl BDI)(FUr BDr)(FRu BRd)(FLd RBu Rfd)(FDl BUl)(FDr BUr)(BLu LBd) 2s 2s 2s 3s 2s 2s 2s.

16 edge pieces, 2 cycles

$[[FR', D^2], b^2l^2r]$ (18 moves): (FUl BDI)(FUr DRb ULb DFr RUB Rdf LDb BDr UBr BUl FRd FDI RFu DLf) 2s 14s.

$[[FB^2, R], f^2b^2d]$ (18 moves): (FUr LBu DLf BRu URf BLd RBd RUB LDb FRd DRb ULb LFd)(FRu DRf ULf) 13s 3s.

$[[FR', D^2], b^2lr^2]$ (18 moves): (FUl UBl URb DRf DLb Rfd BUr FRu FDr BDI DF1 Ldf)(FUr DRb ULb BDr) 12s 4s.

$[[FB, R], b^2r^2ud^2]$ (20 moves): (FUl FRu RBu BLu UFr Rfd RDb RUf LUb LBd DBr)(FLd BDI BRd URb DLb) 11s 5s.

$[[FB^2, R], fb'u'd]$ (20 moves): (FUl BRd FLd UFr RBu LFu)(FRu DRf RUf

LBd LUb RFd RDb URb BLu ULf) 6s 10s.

[[FB, R], $brud'$] (20 moves): (FUl FRu RBu BLu BUr RUf DBr)(FUr FRd BLd DBl DFr LDl RBd RUb DRb) 7s 9s.

[[FR', D^2], b^2lr] (18 moves): (FUl UBl URb DRf DLb RFd DBr BUr)(FUr DRb ULb DFr DBl FDI RFu DLf) 8s 8s.

16 edge pieces, 4 cycles

[[FBR^2, U], f^2b^2r] (22 moves): (FUl RUf BUr BRd UFr URb DLb FDr LFu LDf)(BUl BRu)(LUb RDb)(LUf RDf) 10s 2s 2s 2s.

[[FBR^2, U], bl^2u^2] (22 moves): (FUl BDI FLd)(FUr UBr ULb RUb BUl FDI DRb LDl RBd)(FLu BRu)(LUf RDf) 3s 9s 2s 2s.

[[FB^2R^2, U'], fb^2r] (22 moves): (FUl FLd)(FLu RDf BDr UBr)(FDr DLb UBl URb BDI RUf ULf LDf)(LUb RDb) 2s 4s 8s 2s.

[[FB^2, R], fb^2ud] (20 moves): (FUl FRu DRf RUf LBd)(FUr FLu LDl FRd DRb ULb LFd)(BLu ULf)(BRd URb) 5s 7s 2s 2s.

[[FB, R], $l^2r^2u^2d^2$] (20 moves): (FUl FRu BLu BDI BRd FLd)(FUr FRd BLd BDr BRu FLu)(RUf RDb)(RUb RDf) 6s 6s 2s 2s.

[[FB^2, R], $blu'd^2$] (20 moves): (FUl RFd FLd RBu FRu LFu UBl DRf)(FUr URf)(BLu BRd URb)(BLd DRb LDl) 8s 2s 3s 3s.

[[FR, D^2], $blr'd^2$] (20 moves): (FUl LBd BUr)(FRu FDr BDI DFl)(FLd LUb DRf RBu RDb DLb BRd)(FRd BDr) 3s 4s 7s 2s.

[[FB^2, R], b^2rud] (20 moves): (FUl FRu RBu BLu RUf LBd)(FUr FLu LDl FRd DRb)(FLd FDr LUb)(BRd URb) 6s 5s 3s 2s.

[[FR', D^2], $b^2l^2r^2$] (18 moves): (FUl BDI)(FUr DRb ULb BDr)(FRu FDr URb DRf DLb BUr)(FRd FDI DLf BUl) 2s 4s 6s 4s.

[[FB^2, R], $fb'rud$] (22 moves): (FUl FRu DRf RUf LBd)(FUr FLu ULb FRd DRb)(FLd FDr URb BRd)(BLu ULf) 5s 5s 4s 2s.

[[FB, R], $b^2lr^2d^2$] (20 moves): (FUl UBl DRf)(FUr FRd DRb URf ULb BLd BDr)(FLd DFl DLb)(BRd URb BDI) 3s 7s 3s 3s.

[[FR, D^2], b^2lrd] (20 moves): (FUl FLd BUr)(FRu FDr BDI DFl)(FRd BDr RUb RDf LDl RBd)(BRu DRb ULb) 3s 4s 6s 3s.

[[FB, R], ru^2d^2] (18 moves): (FUl FRu BLu)(FUr FRd BLd DFr DRb)(FLu UBr URf BDr BRu)(FLd BDI BRd) 3s 5s 5s 3s.

$[[FB^2, R], f^2b^2d^2]$ (18 moves): (FU_r DLf BR_u URf)(FR_u DRf ULf)(FLd BL_u BRd URb DLb)(FRd DRb ULb BLd) 4s 3s 5s 4s.

$[[F^2B^2, R], f^2b^2d^2]$ (18 moves): (FL_u DLf BR_u URf)(FR_u DRf BL_u ULf)(FLd BRd URb DLb)(FRd DRb ULb BLd) 4s 4s 4s 4s.

16 edge pieces, 6 cycles

$[[FB^2, R'U], b^2r^2u^2]$ (22 moves): (FU_l DRf)(FU_r BDr)(FL_u LUf BR_u DFr DB_l UBr)(FR_u URb)(BL_u DLb)(LU_b RDb) 2s 2s 6s 2s 2s 2s.

$[[FR^2, U^2], fbr^2d]$ (20 moves): (FU_l BU_r FLd LBd FDr)(FU_r BDr FL_u)(LU_b RUf)(LU_f Rdf)(LD_b RU_b)(LD_f RDb) 5s 3s 2s 2s 2s 2s.

$[[FR^2, U^2], fblr]$ (20 moves): (FU_l BU_r UFr FLd)(FL_u BU_l DB_l DFr)(LU_b RUf)(LU_f Rdf)(LD_b RU_b)(LD_f RDb) 4s 4s 2s 2s 2s 2s.

$[[FBR', U^2], b^2r^2d]$ (22 moves): (FU_l BU_r FDr)(FU_r BDr)(FLd BRd)(FRd BLd)(BU_l DRb URf ULb)(BD_l URb DLb) 3s 2s 2s 2s 4s 3s.

$[[FR, D^2], lru^2d^2]$ (20 moves): (FU_l LBd BU_r)(FL_u DLf BR_u)(FR_u FDr BD_l)(FLd DLb BRd)(FRd BDr)(FD_l LB_u) 3s 3s 3s 3s 2s 2s.

16 edge pieces, 8 cycles

$[[FB, R^2], lru^2d^2]$ (20 moves): (FU_l BD_l)(FU_r BDr)(FL_u BLd)(FR_u BRd)(FLd BL_u)(FRd BR_u)(FD_l BU_l)(FDr BU_r) 2s 2s 2s 2s 2s 2s 2s 2s.

17 edge pieces, 1 cycle

$[[FB^2, R], b^2lud']$ (20 moves): (FU_l FR_u RB_u BL_u UFr RFd RDb LU_b BRd URb FLd RUf LF_u DLb LBd UB_l DRf) 17s.

17 edge pieces, 3 cycles

$[[FR, D^2], blru'd']$ (22 moves): (FU_l BRd LBd LU_b DRf FR_u FDr BD_l LDf RB_u RDb DLb BU_r)(FL_u FD_l)(FRd BDr) 13s 2s 2s.

$[[FB^2, R], b^2lud^2]$ (20 moves): (FU_l FR_u RB_u BL_u BRd URb RFd RDb LU_b LBd UB_l DRf)(FU_r URf)(FL_u LD_b LFd) 12s 2s 3s.

$[[FR, D^2], fblr'd]$ (22 moves): (FU_l FLd FDr BD_l DF_l DBr LU_b RUf RFd UFr FR_u)(BR_u DRb DLf Rdf)(BRd DLb) 11s 4s 2s.

$[[FB, R], lr^2ud^2]$ (20 moves): (FU_l FR_u RB_u BL_u UFr RFd LBd DBr UB_l DRf)(FLd DF_l URb BD_l BRd)(RUf RDb) 10s 5s 2s.

$[[FB^2, R], b^2lu^2d^2]$ (20 moves): (FUl DLb FLd FRu BLu BRd URb UBl DRf)(FUr URf)(FLu FRd DRb ULb BLd BRu) 9s 2s 6s.
 $[[FB^2, R], b^2lud]$ (20 moves): (FUl FRu RBu BLu RUf LBd UBl DRf)(FUr FLu LDl FRd DRb ULb LFd)(BRd URb) 8s 7s 2s.
 $[[FB^2, R], fb^2u^2d']$ (20 moves): (FUl DLb LBd RBu BLu UFr RFd RDb LUb BRd URb)(FLu LFd LUf)(FRu DRf RUf) 11s 3s 3s.
 $[[FR', D^2], b^2lr^2u]$ (20 moves): (FUl UBl URb DRf DLb RFd BUr RBu DF1 LDf)(FUr DRb ULb BDr)(FRu FDr BDI) 10s 4s 3s.
 $[[FB, R], bru^2d']$ (20 moves): (FUl FRu BLu)(FUr FRd BLd DBl DFr LDl RBd RUB DRb)(FLu UBr URf BDr BRu) 3s 9s 5s.
 $[[FR', D^2], fb^2lr^2]$ (20 moves): (FUl LUl DBr UFr RDb LDf)(FRu FDr BDI DF1 DRf DLb RFd BUr)(BUl RUB URf) 6s 8s 3s.
 $[[FB, R], brud^2]$ (20 moves): (FUl FRu RBu BLu BUr RUf DBr)(FUr FRd LFd DBl RBd RUB DRb)(FDr DLb LBd) 7s 7s 3s.
 $[[FB, R], fb^2u^2d']$ (20 moves): (FUl FRu DRf RUf ULf LFu DBr RBu BLu)(FUr FRd BLd DBl)(BRd URb RDb DLb) 9s 4s 4s.
 $[[FB, R], blr^2u^2]$ (20 moves): (FUl FRu BLu UBl DRf)(FUr BDr BRu FLu)(FRd RBd RUB DBl FDI DRb URf LDl) 5s 4s 8s.
 $[[FBR^2, U], fbd]$ (22 moves): (FUl RBu DRf RUf ULf LDf UBl)(FUr UBr ULb RBd)(FLd LBd DLb RFd URb RDb) 7s 4s 6s.
 $[[FB, R], fb^2ud^2]$ (20 moves): (FUl FRu DRf RUf ULf BLu DBr)(FUr FRd DRb ULb BLd)(FLd BDI BRd URb DLb) 7s 5s 5s.
 $[[FR', D^2], fb^2l'r']$ (20 moves): (FUl LUl BUr DRf DLb)(FUr DRb DLf RFu DBl BUl)(FRd RUB URf FDI BDr DFr) 5s 6s 6s.

17 edge pieces, 5 cycles

$[[FR^2, U^2], fblr^2]$ (20 moves): (FUl BUr FDr UBl BDI DBr LFu UFr FLd)(LUl RUf)(LUf RDr)(LDl RUB)(LDf RDb) 9s 2s 2s 2s 2s.
 $[[FB, L^2R], bru^2]$ (22 moves): (FUl FLd)(FUr DFr URf)(FLu BRu)(FRu BLu)(FRd RBd RUB DRb BDr BLd UBr LDl) 2s 3s 2s 2s 8s.
 $[[FB, RU], fb^2d^2]$ (22 moves): (FUr DBl)(FRu DRf RFd BUr LBd RUf ULf)(FLd BRd)(BUl DLf)(LUl URb DLb RDb) 2s 7s 2s 2s 4s.
 $[[FR', D^2], fbl'r'd]$ (22 moves): (FUl DLb)(FUr DRb DLf RFu DBl

BUl)(FLd FDr)(FRd ULb URf FDI BDr)(BUr DRf) 2s 6s 2s 5s 2s.
 $[[FB^2, R], fb^2lud]$ (22 moves): (FUl FRu DRf)(FUr FLu LDl FRd DRb
 ULb LFd)(BUl URf BLd)(BLu ULf)(BRd URb) 3s 7s 3s 2s 2s.
 $[[FBR^2, U], fb^2u]$ (22 moves): (FUl BLu LDf UBl)(FUr RUb LDl)(FLu
 RFu URf LUf BRu RDf)(BUr BRd)(LUb RDl) 4s 3s 6s 2s 2s.
 $[[FB^2, R], fb^2rud]$ (22 moves): (FUl FRu DRf RUf LDl)(FUr FLu LDl
 FRd DRb)(FLd FDr LUl)(BLu ULf)(BRd URb) 5s 5s 3s 2s 2s.
 $[[FR, D^2], fbl'r'd]$ (22 moves): (FUr RFu DBl BUl)(FLd FDr)(FRd FDI
 BDr ULb URf)(BRu DRb DLf RDf)(BRd DLl) 4s 2s 5s 4s 2s.
 $[[FBR', U'], br^2u]$ (22 moves): (FUl LUl URb FLd RDl UBl)(FUr
 BDr)(FLu RFu LUf)(FDr BRd BUr)(BRu LBu DBl) 6s 2s 3s 3s 3s.
 $[[FR, D^2], b^2lrd^2]$ (20 moves): (FUl LDl BUr)(FRu FDr BDI DFl)(FLd
 URb DRf DLl BRd)(FRd BDr)(BRu DRb ULl) 3s 4s 5s 2s 3s.
 $[[FR, D^2], fblrd]$ (22 moves): (FUl FLd BUr)(FRu FDr BDI DFl)(FRd BDr
 ULb URf)(BRu DRb DLf RDf)(BRd DLl) 3s 4s 4s 4s 2s.
 $[[FB, R], blrd^2]$ (20 moves): (FUl UBl DRf)(FUr FRd LFd FDI DRb)(FDr
 DLl LDl)(BUr RUf DBr)(BRd URb BDI) 3s 5s 3s 3s 3s.
 $[[FB', R], blru'd^2]$ (22 moves): (FUl BDI RUf DRf)(FUr FRd LFd)(FLu
 BUl BRu RFu)(FDr DLl LDl)(BUr BRd URb) 4s 3s 4s 3s 3s.

17 edge pieces, 7 cycles

$[[FBR^2, U^2], fbrd]$ (24 moves): (FUl BUr UFr FDr UBl)(FLd BRd)(FRd
 BLd)(LUl RUf)(LUf RDf)(LDl RUl)(LDf RDl) 5s 2s 2s 2s 2s 2s.
 $[[FR^2, U^2], fblrd]$ (22 moves): (FUl BUr FLd)(FUr BLd)(FLu BUl DBl
 DFr)(LUl RUf)(LUf RDf)(LDl RUl)(LDf RDl) 3s 2s 4s 2s 2s 2s.
 $[[FB^2, RU'], b^2lr]$ (22 moves): (FUl DBr FLd)(FUr UBr)(FLu FDI
 DFr)(FRd RDf)(BUl DBl)(BRd URb DLl)(LUl RDl) 3s 2s 3s 2s 2s 3s 2s.

18 edge pieces, 2 cycles

$[[FB, RU], bud]$ (22 moves): (FUl LFu FRu RBu BLu DBr DLl FLd LDl
 UFr DRf BDI BRd RFd URb RDl)(BUr LUl) 16s 2s.
 $[[FB^2, R], f^2b^2ud^2]$ (20 moves): (FUl FRu DRf ULf RBu RUf UFr LDf BLu
 BRd URb RFd RDl LUl LDl)(FLu LDl LFd) 15s 3s.

$[[FB^2, RU], lr'd]$ (22 moves): (FUl UBl BDI LFu UFr DRf BLu RUf BUr DBr LBd BRd RFd FLd)(FDl ULb DFr LUf) 14s 4s.
 $[[FB^2, R], f^2b^2ru]$ (20 moves): (FUl FRu DRf ULf RBu RUf LDf BLu LFu DLb BRd URb LBd)(FUr DFr ULb FRd DRb) 13s 5s.
 $[[FB, RU'], bru]$ (22 moves): (FUr RDf ULb RUB DRb LDf FRd DFr RFu BRu LBu UBr)(FLu RBd URf BDr BUI LUf) 12s 6s.
 $[[FB^2, R], f^2lu'd]$ (22 moves): (FUl BRd URb BLu ULf FRu DRf)(FUr BRu FLu BUI URf BLd LDf FRd DRb ULb LFd) 7s 11s.
 $[[FB, RU], blr]$ (22 moves): (FUl UBl BDI DF1 RDf DLb RFd URb RBu FLd)(FUr DFr FLu RBd URf BDr UBr ULb) 10s 8s.
 $[[FB, R], lrud]$ (20 moves): (FUl FRu RBu BLu BUr RUf DBr UBl DRf)(FUr FDI RUB DBl RBd FRd LFd DFr DRb) 9s 9s.

18 edge pieces, 4 cycles

$[[FB, RU], bud^2]$ (22 moves): (FUl LFu FRu RBu BLu DBr DLb LBd DRf RFd URb RDb)(FUr DBl)(FLd BRd)(BUr LUb) 12s 2s 2s 2s.
 $[[FR, D^2], blru^2d']$ (22 moves): (FUl BRd LBd LUb DRf LFu LDf RBu RDb DLb BUr)(FRu FDr BDI)(FRd BDr)(FDI LBu) 11s 3s 2s 2s.
 $[[FB, RU], blr^2]$ (22 moves): (FUl UBl BDI DF1 RDf DLb RFd URb RBu FLd)(FUr BDr)(FLu URf)(FDr BRd BUr LUb) 10s 2s 2s 4s.
 $[[FB, RU'], b^2lu']$ (22 moves): (FUl UBl DBr RBu FLd)(FUr RUB RFu FLu LBu LUf DBl FDI LDf)(FRd RDf)(LUB RDb) 5s 9s 2s 2s.
 $[[FB, RU], b^2u^2d]$ (22 moves): (FUl DBr)(FUr RDf DBl RBd FRd UBr LFd BLd)(FLu BRu)(FRu BLu LUb URb DLb RDb) 2s 8s 2s 6s.
 $[[FB^2, R], f^2b^2ud]$ (20 moves): (FUl FRu DRf ULf RBu RUf LBd)(FUr FLu LDf FRd DRb ULb LFd)(BLu LDf)(BRd URb) 7s 7s 2s 2s.
 $[[FR, D^2], blrud^2]$ (22 moves): (FUl LBd BUr)(FRu FDr BDI)(FLd LUb DRf BLu LDf DF1 RBu RDb DLb BRd)(FRd BDr) 3s 3s 10s 2s.
 $[[FR, D^2], fblr^2d]$ (22 moves): (FUl FLd UFr)(FRu FDr BDI DF1 DBr LUb RUf RFd BUr)(BRu DRb DLf RDf)(BRd DLb) 3s 9s 4s 2s.
 $[[FB^2, R], b^2lrud]$ (22 moves): (FUl FRu RBu BLu RUf LBd UBl DRf)(FUr FLu LDf FRd DRb)(FLd FDr LUb)(BRd URb) 8s 5s 3s 2s.
 $[[FR, D^2], b^2lrud']$ (22 moves): (FUl BRd LBd URb DRf DLb BUr)(FRu

$FDr\ BDI(FRd\ BDr)(FDI\ BRu\ DRb\ ULb\ LBU\ DLf)$ 7s 3s 2s 6s.
 $[[FB^2, RU], blu']$ (22 moves): $(FUI\ DLb\ RFd\ BRd\ BUr\ LUb\ DBr\ FLd)(FLu\ LBU\ BRu\ RFu)(FDI\ RUb\ BUI\ DBI)(BLd\ DRb)$ 8s 4s 4s 2s.
 $[[FB^2, R], fb^2lu'd']$ (22 moves): $(FUI\ FLd\ ULf\ FRu\ DRf)(FUr\ FRd\ DRb\ ULb\ RBd\ RUB\ LBU)(FLu\ BUI\ URf\ BRu)(BLd\ LDb)$ 5s 7s 4s 2s.
 $[[FB^2, L'R], bu'd^2]$ (22 moves): $(FUI\ RFd\ ULf\ RUf\ BRd\ DF1)(FUr\ RFu\ FLu\ LBU\ DFr\ BRu)(FLd\ LBd)(LUB\ URb\ RDb\ DLb)$ 6s 6s 2s 4s.
 $[[FB, R], lr^2u^2d^2]$ (20 moves): $(FUI\ FRu\ BLu\ UBI\ DRf)(FUr\ FRd\ BLd\ BDr\ BRu\ FLu)(FLd\ DF1\ URb\ BDI\ BRd)(RUf\ RDb)$ 5s 6s 5s 2s.
 $[[FB, R], blrud]$ (22 moves): $(FUI\ FRu\ RBu\ BLu\ BUr\ RUf\ DBr\ UBI\ DRf)(FUr\ FDI\ DRb)(FLd\ FDr\ DLb)(BRd\ URb\ BDI)$ 9s 3s 3s 3s.
 $[[FR', D^2], f^2b^2lr']$ (20 moves): $(FUI\ DRf\ DLb\ RFd\ UFr\ RDb\ LDf\ FRu)(FDI\ BDr\ DFr\ DBI)(BUr\ RUf\ LUb)(BUI\ RUB\ LUf)$ 8s 4s 3s 3s.
 $[[FB, R], bru^2d^2]$ (20 moves): $(FUI\ FRu\ BLu)(FUr\ FRd\ LFd\ DBI\ RBd\ RUB\ DRb)(FLu\ UBr\ URf\ BDr\ BRu)(FDr\ DLb\ LBd)$ 3s 7s 5s 3s.
 $[[FR', D^2], f^2b^2lr]$ (20 moves): $(FUI\ DRf\ DLb\ RFd\ DBr\ BUr)(FUr\ DRb\ DLf)(FRu\ RUf\ LUb\ FDr\ BDI\ DF1)(BUI\ RUB\ LUf)$ 6s 3s 6s 3s.
 $[[FR, D^2], fblr^2d']$ (22 moves): $(FUI\ BRd\ DLb\ UFr)(FRu\ FDr\ BDI\ DF1\ DBr\ RFd\ BUr)(BRu\ DRb\ DLf\ Rdf)(BLd\ ULb\ URf)$ 4s 7s 4s 3s.
 $[[FB^2, L'R], bu^2d']$ (22 moves): $(FUI\ LBd\ DF1\ FLd\ BRd)(FUr\ DFr\ FLu\ BRu\ RFu\ LBU)(FRd\ LUf\ URf)(LUB\ URb\ RDb\ DLb)$ 5s 6s 3s 4s.
 $[[FB', R], bl^2ru^2d']$ (22 moves): $(FUI\ FRu\ BLu\ BDI\ DRf)(FUr\ FRd\ BLd)(FLu\ FDI\ URf\ BUI\ BRu)(FDr\ DLb\ BRd\ URb\ BUr)$ 5s 3s 5s 5s.
 $[[FB, LR], rud]$ (22 moves): $(FUI\ DF1\ UFr\ BDI\ UBI\ DBr)(FLu\ RFu\ BRu\ LBU)(FLd\ LBd\ BRd\ RFd)(LUf\ DRb\ LDb\ URf)$ 6s 4s 4s 4s.
 $[[FB, R], b^2lr^2u^2]$ (20 moves): $(FUI\ FRu\ BLu\ UBI\ DRf)(FUr\ BDr\ BRu\ FLu)(FRd\ DRb\ URf\ ULb)(FDI\ LDb\ RBd\ RUB\ DBI)$ 5s 4s 4s 5s.

18 edge pieces, 6 cycles

$[[FB, RU], bu^2d^2]$ (22 moves): $(FUI\ DBr)(FUr\ DBI)(FLu\ BRu)(FRu\ BLu\ DLb\ LBd\ DRf\ RFd\ URb\ RDb)(FLd\ BRd)(BUr\ LUb)$ 2s 2s 2s 8s 2s 2s.
 $[[FR^2, U^2], fblr^2d]$ (22 moves): $(FUI\ BUr\ FLd)(FUr\ BLd\ DFr\ BUI\ DBI\ BDr\ FLu)(LUB\ RUf)(LUf\ Rdf)(LDb\ RUB)(Ldf\ RDb)$ 3s 7s 2s 2s 2s 2s.

$[[FB, RU], b^2u^2d^2]$ (22 moves): (FUl DBr)(FUr DBl)(FLu BRu)(FRu BLu
 LUb URb DLb RDb)(FLd BRd)(FRd UBr BLd Rdf) 2s 2s 2s 6s 2s 4s.

$[[FR^2, U^2], fbl^2r^2]$ (20 moves): (FUl BUr FDr BDI FLd)(FUr BUl FDI BDr
 FLu)(LUB RUF)(LUf Rdf)(LDb RUB)(Ldf RDb) 5s 5s 2s 2s 2s 2s.

$[[FB, L^2R], b^2ru^2]$ (22 moves): (FUl FLd)(FUr DFr URf)(FLu BRu)(FRu
 BLu)(FRd DRb BDr BLd UBr ULb)(BRd URb DLb) 2s 3s 2s 2s 6s 3s.

$[[FB, RU], bl^2r^2]$ (22 moves): (FUl BDI)(FUr BDr)(FLu URf)(FLd RDb
 DLb Rfd URb)(FDI BRu BUl)(FDr BRd BUr LUb) 2s 2s 2s 5s 3s 4s.

$[[FB^2, R'U'], bl^2r^2]$ (22 moves): (FUl BDI BUr FDr)(FUr BDr BUl
 FDI)(FLu LBu)(FRu RDb DLb RBu)(FLd LBd)(LUB URb) 4s 4s 2s 4s 2s
 2s.

$[[FBR^2, U], b^2l^2u]$ (22 moves): (FUl BDI FLd)(FUr RUB BUl FDI
 LDb)(FLu RFu Rdf)(BUr BRd)(BRu LBu LUf)(LUB RDb) 3s 5s 3s 2s 3s
 2s.

$[[FR, D^2], fblrd^2]$ (22 moves): (FUl LBd BUr)(FRu FDr BDI DFI)(FLd
 LUb RUF)(FRd BDr)(BRu DRb DLf Rdf)(BRd DLb) 3s 4s 3s 2s 4s 2s.

$[[FBR', U'], b^2r^2u]$ (22 moves): (FUl LUb RDb)(FUr BDr)(FLu RFu
 LUf)(FLd DLb UBl URb)(FDr BRd BUr)(BRu LBu DBl) 3s 2s 3s 4s 3s 3s.

$[[FB, R], b^2lrd^2]$ (20 moves): (FUl UBl DRf)(FUr FRd DRb)(FLd DFI
 DLb)(FDr LUb LBd)(BUr RUF DBr)(BRd URb BDI) 3s 3s 3s 3s 3s 3s.

18 edge pieces, 8 cycles

$[[FR'B, U^2], b^2l^2r^2d^2]$ (24 moves): (FUl BUr)(FUr BUl)(FLu URf)(FLd
 BRd URb DLb)(FDI BDr)(FDr BDI)(LUB RDb)(LUf Rdf) 2s 2s 2s 4s 2s
 2s 2s 2s.

$[[FR^2, D^2B'], blr^2]$ (22 moves): (FUl UBl)(FUr BDr)(FRu BRd)(FRd
 UBr)(FDI DBI)(FDr RBu)(LUB DRf RUF)(LDb RUB DRb) 2s 2s 2s 2s 2s
 2s 3s 3s.

19 edge pieces, 1 cycle

$[[FB, RU'], blr]$ (22 moves): (FUl UBl BDI DFI RDb DLb Rfd FDr Lfu
 BRd RUF DBr BUr UFr DRf LUb URb RBu FLd) 19s.

19 edge pieces, 3 cycles

$[[FB, RU'], b^2lr]$ (22 moves): (FUl UBl BDI DFl DLb FDr LFu BRd RUf DBr BUr UFr URb RBu FLd)(FRd Rdf)(LUb RDb) 15s 2s 2s.

$[[FB, RU'], blr^2]$ (22 moves): (FUl UBl BDI DFl RDb DLb RFd DBr UFr DRf LUb URb RBu FLd)(FLu URf)(FDr BRd BUr) 14s 2s 3s.

$[[FB^2, R'U'], rud]$ (22 moves): (FUl ULf DRf UFr UBl RDb LUb FDr FRu RBu BLu DBr BUr)(FLu DBl)(FLd LBd BRd RFd) 13s 2s 4s.

$[[FB^2, RU], ru^2d]$ (22 moves): (FUl BRd RFd FLd LBd)(FUr RDf RFu LBu URf DFr BRu FLu DBl LUf BDr UBr)(RUb DRb) 5s 12s 2s.

$[[FBR^2, U], fb^2l^2r]$ (24 moves): (FUl RBu DRf RUf BUr BRd UFr URb UBl BDI FLd)(FLu LUf DLf FDI LDb DFr)(LUb RDb) 11s 6s 2s.

$[[FB, RU'], bud^2]$ (22 moves): (FUr RDf ULb DBl RUb DRb LDb BLd UBr FRd)(FLu RFu BRu LBu BDr BUl LUf)(FLd BRd) 10s 7s 2s.

$[[FB^2, RU], fbr^2]$ (22 moves): (FUr BDr)(FLu DLf BUl BRu RFu RDf URf LUf)(FRd RDb DFr DBl UBr ULb RUb DRb LDb) 2s 8s 9s.

$[[FB, R], b^2lr^2ud^2]$ (22 moves): (FUl FRu RBu BLu UFr RFd RDb RUf LUb LBd DBr UBl DRf)(FLd DFl DLb)(BRd URb BDI) 13s 3s 3s.

$[[FBR', U'], bl^2ru]$ (24 moves): (FUl LUb URb BRd FLd DBr BUr UFr FDr RDb DFl BLu)(FLu URf RFu LUf)(BUl DBl BRu) 12s 4s 3s.

$[[FB, R], blr^2u^2d^2]$ (22 moves): (FUl FRu BLu UBl DRf)(FUr FRd LFd FDI DRb URf LDb BLd BDr BRu FLu)(BRd URb BDI) 5s 11s 3s.

$[[FBR^2, U], br^2ud]$ (24 moves): (FUr DFr URf UBr ULb RDb BDr RFu RDf FLu)(FLd LBd DLb RFd URb RDb)(BRu LBu LUf) 10s 6s 3s.

$[[FB, R], fbru^2d']$ (22 moves): (FUl FRu DRf RUf DBr RBu BLu)(FUr FRd BLd DBl DFr LDb RDb RUb DRb)(FLu UBr LUf) 7s 9s 3s.

$[[FB^2, R'U'], r^2ud]$ (22 moves): (FUl LFu ULf FRu RBu BLu DRf URb)(FUr URf DRb RDb FRd LFd BLd BDr)(FDr BDI BUr) 8s 8s 3s.

$[[FB^2, R'U'], ru'd]$ (22 moves): (FUl UFr UBl RDb LUb FDr BLu DBr BUr DRf ULf)(FLu DBl BRu RFu)(FLd LBd BRd RFd) 11s 4s 4s.

$[[FBR', U], bl^2r^2u]$ (24 moves): (FUl BDI LFu BRd FRu)(FUr DFr URf UBr ULb RUb BUl FDI DRb BDr)(FLd BLu ULf RBu) 5s 10s 4s.

$[[FBR^2, U], fbr^2u]$ (24 moves): (FUl BLu LDF UBl)(FUr DFr LUf BRu RDf FLu)(FRu RUf BUr LUb URb RDb DLb BRd DBr) 4s 6s 9s.

$[[FB', RU'], blu]$ (22 moves): (FUl UBl RUf ULf UFr BDI LBd FLd)(FLu

RFu BRu LBu)(FRd RBd Rdf ULb RUb DRb LDb) 8s 4s 7s.

[[FB, R], $lrud^2$] (20 moves): (FUl FRu RBu BLu BUr RUf DBr UBl DRf)(FUr FRd BLd DFr DRb)(FLd DFl URb BDI BRd) 9s 5s 5s.

[[FB^2R, D], b^2lud] (24 moves): (FUl DRf BUr LFu FLd URb)(FRu LBd BRd RBu LDf)(FRd LBu BUI DBI DRb ULb FDI LDl) 6s 5s 8s.

[[FR, D^2], $b^2lr^2u'd'$] (22 moves): (FUl BRd LBd URb DRf DLb UFr)(FLu FDI BDr FRd UBr)(FRu FDr BDI LDf RBu RDb LUb) 7s 5s 7s.

[[FB^2, RU'], fbr] (22 moves): (FUl DBr BUr UFr FDr LFu BDI)(FRu DRf LUb URb RDb RBu)(FRd RBd URf LUf DLf LDl) 7s 6s 6s.

19 edge pieces, 5 cycles

[[$FB^2, R'U'$], rud^2] (22 moves): (FUl ULf DRf UFr RDb FDr FRu RBu BLu DBr BUr)(FLu DBI)(FLd BRd)(FRd BLd)(BUI ULb) 11s 2s 2s 2s 2s.

[[FB, RU'], bu^2d^2] (22 moves): (FUr RDf ULb DBI RUb DRb LDl BLd UBr FRd)(FLu BRu)(FRu BLu UBl)(FLd BRd)(BDr LUf) 10s 2s 3s 2s 2s.

[[$FB^2, R'U'$], $ru'd^2$] (22 moves): (FUl UFr RDb FDr BLu DBr BUr DRf ULf)(FLu DBI BRu RFu)(FLd BRd)(FRd BLd)(BUI ULb) 9s 4s 2s 2s 2s.

[[FB^2, RU], $ru'd^2$] (22 moves): (FUl RDb RFd LBd URb)(FUr BRu RFu FLu DBI LUf BDr UBr)(FLd BRd)(FDr BLu)(RUf DRf) 5s 8s 2s 2s 2s.

[[$FB, R'U$], b^2u^2d] (22 moves): (FUl FRu URb BDI DLb BLu)(FUr URf RBd FRd LFd BLd BDr)(FLu BRu)(BUr ULf)(LUb RDb) 6s 7s 2s 2s 2s.

[[FR, D^2], $blru^2d^2$] (22 moves): (FUl LBd BUr)(FLu DLf BRu DRb LDl RBd LFd ULb RDf)(FRu FDr BDI)(FRd BDr)(FDl LBu) 3s 9s 3s 2s 2s.

[[FB^2, RU], fb^2r^2] (22 moves): (FUr BDr)(FLu DLf BUI BRu RFu RDf URf LUf)(FRd DFr DBI UBr)(BRd URb DLb)(LUb RDb) 2s 8s 4s 3s 2s.

[[FB^2, R], f^2b^2rud] (22 moves): (FUl FRu DRf ULf RBu RUf LBd)(FUr FLu LDl FRd DRb)(FLd FDr LUb)(BLu LDf)(BRd URb) 7s 5s 3s 2s 2s.

[[FB^2, RU'], fbr^2] (22 moves): (FUl LFu)(FUr BDr)(FRu DRf LUb URb RDb RBu)(FRd RBd URf LUf DLf LDl)(FDr BDI BUr) 2s 2s 6s 6s 3s.

[[FB, LR], rud^2] (22 moves): (FUl DFl UFr UBl FDr BDI DBr)(FLu RFu BRu LBu)(FLd BRd)(FRd BLd)(LUf DRb LDl URf) 7s 4s 2s 2s 4s.

[[$FB, L'R$], bru^2] (22 moves): (FUl UFr FDr DBr DFl BUr)(FLu BRu)(FRu BLu)(FLd RFd BRd LBd)(LUb URb RDb ULf RUf) 6s 2s 2s 4s 5s.

$[[FR, D^2], fbl^2r'ud]$ (24 moves): (FUl UFr RBu RDb LDf)(FRu UBf FLd FDr BDI)(FRd FDI BDr ULb URf)(BLu DRf)(BRd DLb) 5s 5s 5s 2s 2s.
 $[[FB^2, R'U], r^2ud^2]$ (22 moves): (FUl LFu ULf FRu RBu BLu DRf URb)(FUr DRb BDr)(FLd BRd)(FRd BLd URf)(FDr BDI BUr) 8s 3s 2s 3s 3s.
 $[[FR, D^2], fblr^2d^2]$ (22 moves): (FUl LBd UFr)(FRu FDr BDI DFf DBr RFd BUr)(FLd LUb RUf)(BRu DRb DLf RDf)(BRd DLb) 3s 7s 3s 4s 2s.
 $[[FR, D^2], b^2lrud^2]$ (22 moves): (FUl LBd BUr)(FRu FDr BDI)(FLd URb DRf DLb BRd)(FRd BDr)(FDf BRu DRb ULb LBU DLf) 3s 3s 5s 2s 6s.
 $[[FB^2R', U'], l^2r^2ud^2]$ (24 moves): (FUl BDI BUr FDr)(FUr BDr BUf FDI)(FLu LBU RUB)(FRu ULf)(FLd LBd RUf RFd BRd LUb) 4s 4s 3s 2s 6s.
 $[[FR, D^2], fbl^2r^2d]$ (22 moves): (FUl BUr FRu FDr BDI)(FUr BUf LFd)(FRd FDI BDr ULb URf)(BRu DRb DLf RDf)(BRd DLb) 5s 3s 5s 4s 2s.
 $[[FB^2, R'U'], r^2u^2d]$ (22 moves): (FUl DRf)(FUr BUf DRb ULb BDr)(FLu RFu LBU BRu)(FLd LBd BRd RFd)(FDr BDI BUr ULf) 2s 5s 4s 4s 4s.
 $[[FB', R], b^2lr^2ud^2]$ (22 moves): (FUl FRu RBu BLu BDI RUf DRf)(FUr FRd DRb)(FLd FDr DLb)(BUr BRd URb)(BLd BDr ULb) 7s 3s 3s 3s 3s.
 $[[FBR, U], lr^2ud]$ (24 moves): (FUl LFu UFr FLd)(FRu UBf BDI URb LBd DBr)(FRd ULb RBd)(FDr RUf BUr)(BRu LBU LUf) 4s 6s 3s 3s 3s.
 $[[FB, R], b^2ru^2d^2]$ (20 moves): (FUl FRu LBU)(FUr FRd DRb)(FLu UBr URf BDr BRu)(FLd BDI BRd URb DLb)(FDr LUb LBd) 3s 3s 5s 5s 3s.
 $[[FB', R], blr^2u'd^2]$ (22 moves): (FUl BDI RUf DRf)(FUr FRd LFd DFf DRb)(FLu BUf BRu RFu)(BUr BRd URb)(BLd BDr LDf) 4s 5s 4s 3s 3s.
 $[[FB, LR], rud']$ (22 moves): (FUl DFf UFr DBr)(FLu RFu BRu LBU)(FLd RFd BRd LBd)(FDr UBf BDI)(LUf DRb LDf URf) 4s 4s 4s 3s 4s.

19 edge pieces, 7 cycles

$[[FB^2, L'R], b^2ru^2]$ (22 moves): (FUl BRd)(FUr DFr BDr RUB LDb ULb DRb)(FLu BRu)(FRu LBU)(FLd ULf)(FRd URf)(FDf BLd) 2s 7s 2s 2s 2s 2s 2s.
 $[[FB, R'U], b^2u^2d^2]$ (22 moves): (FUl FRu URb BDI DLb LBU)(FUr FRd BLd)(FLu BRu)(FLd BRd)(BUr ULf)(BDr URf)(LUB RDb) 6s 3s 2s 2s 2s

2s 2s.

$[[FB^2, R'D'], f^2b^2d^2]$ (22 moves): (FUl BDI)(FUr BDr)(FLd BLu BRd DRf Ulf)(FRd BLd)(FDr LUb RBu RDb)(LDb RUb)(LDf RUf) 2s 2s 5s 2s 4s 2s 2s.

$[[FR^2, U^2], fbl^2r^2d]$ (22 moves): (FUl BUr FLd)(FUr BUI FDI BDr FLu)(FDr BDI LBd)(LUb RUf)(LUf Rdf)(LDb RUb)(LDf RDb) 3s 5s 3s 2s 2s 2s 2s.

$[[FB^2, L'R], br'u^2]$ (22 moves): (FUl BRd)(FUr UBr LDb DFr)(FLu BRu)(FRu BLu)(FLd RFd Ulf RUf)(FDI BLd)(LUb URb RDb) 2s 4s 2s 2s 4s 2s 3s.

$[[FB, RU'], b^2u^2d^2]$ (22 moves): (FUr RUb LDb)(FLu BRu)(FRu BLu UBl)(FLd BRd)(FRd Rdf BLd UBr)(BDr LUf)(BDI RDb LUb) 3s 2s 3s 2s 4s 2s 3s.

$[[FB^2, RU'], f^2b^2r^2]$ (22 moves): (FUl LFu)(FUr BDr)(FRu LUb RDb)(FRd LUf Rdf)(FDr BDI BUr)(BRu URf DLf)(BRd URb DLb) 2s 2s 3s 3s 3s 3s 3s.

19 edge pieces, 9 cycles

$[[FBR^2, U^2], fblr^2d]$ (26 moves): (FUl BUr)(FUr DFr BUI)(FLd BRd)(FRd BLd)(BDr DBI)(LUb RUf)(LUf Rdf)(LDb RUb)(LDf RDb) 2s 3s 2s 2s 2s 2s 2s 2s 2s.

20 edge pieces, 2 cycles

$[[FBR^2, U], fb^2l^2r^2]$ (24 moves): (FUl RBu DRf RUf BUr BRd FDr Ulf LDf DFf DLb DBr LFu UFr URb UBl BDI FLd)(LUb RDb) 18s 2s.

$[[FBR^2, U], blr^2u]$ (24 moves): (FUl UBl BDI RDb DLb BRd DBr FRu DRf LFu UFr FDr RUf BUr LUb URb FLd)(BRu LBu LUf) 17s 3s.

$[[FB^2, RU'], blu]$ (22 moves): (FUl UBl Ulf RDb DLb RFd BRd DRf LUb URb LBd BDI DFf UFr DBr FLd)(FLu RFu BRu LBu) 16s 4s.

$[[FBR^2, U], fb^2r^2d]$ (24 moves): (FUl RBu DRf RUf BUr RFd RDb FLd LBd LUb BRd FDr Ulf LDf UBl)(FUr RUb LDb BDr FLu) 15s 5s.

$[[FBR^2, U], fbr^2d]$ (24 moves): (FUl RBu DRf RUf BUr LUb BRd DBr LFu UFr FDr Ulf LDf UBl)(FLd LBd DLb RFd URb RDb) 14s 6s.

$[[FB, R'U], bld]$ (22 moves): (FUl UBl BDI DFf DRf RBu LBd DBr UFr

RUf BRd RFd FLd)(FRu BUr LUb URb RDb DLb ULf) 13s 7s.

[[FBR', U], $lr'ud$] (24 moves): (FUl UBl BDI LFu UFr BUr DBr FLd)(FRu DF1 BLu ULf RBu URb LBd FDr RFd LUb BRd RUf) 8s 12s.

[[FB, RU], $lrud'$] (24 moves): (FUl LFu LBd DF1 URb BLu BUr UFr FLd)(FRu RBu RFd BRd RUf DBr RDb UBl BDI DRf FDr) 9s 11s.

[[FB^2, RU'], bru] (22 moves): (FUl DBr BUr UFr FDr FRu RBu BLu LFu BDI)(FRd RBd Rdf ULb RUB BLd BUl LUf DRb LDb) 10s 10s.

20 edge pieces, 4 cycles

[[FB^2, RU'], blu^2] (22 moves): (FUl UBl RDb DLb RFd BRd DRf LUb URb BDI DF1 UFr DBr FLd)(FLu BRu)(FRu BLu)(BLd LUf) 14s 2s 2s 2s.

[[$FB, R'U$], b^2ld] (22 moves): (FUl UBl BDI DF1 DRf RBu LBd DBr UFr RUf BRd RFd FLd)(FRu URb DLb)(BUr ULf)(LUb RDb) 13s 3s 2s 2s.

[[FB^2, RU'], bl^2u] (22 moves): (FUl BDI)(FUr LFd)(FLu RFu BRu LBu)(FRd RBd Rdf ULb RUB BLd FDI BDr BUl LUf DRb LDb) 2s 2s 4s 12s.

[[FBR^2, U], $f^2b^2r^2d$] (24 moves): (FUl RUf BUr RFd RDb FLd LBd LUb BRd FDr Ldf)(FUr RUB LDb BDr FLu)(BUl BRu)(LUf Rdf) 11s 5s 2s 2s.

[[FB^2, RU'], b^2ru] (22 moves): (FUl DBr BUr UFr FDr FRu RBu BLu LFu BDI)(FRd Rdf)(BUl LUf LDb RBd RUB BLd)(LUb RDb) 10s 2s 6s 2s.

[[$FB^2, R'D$], b^2rd] (22 moves): (FUr BUl RFu URf DFr BDr UBr)(FLd BDI BLu LUb RBu RDb LBd BRd RFd)(FDI DLf)(LDb RUB) 7s 9s 2s 2s.

[[FB^2, RU'], bru^2] (22 moves): (FUl DBr BUr UFr FDr RBu LFu BDI)(FRu BLu)(FRd RBd Rdf ULb RUB BUl DRb LDb)(BLd LUf) 8s 2s 8s 2s.

[[FBR^2, U], b^2l^2ru] (24 moves): (FUl BDI FLd)(FUr RUB BUl FDI LDb DFr RFu Rdf FLu URf UBr RBd)(BRu LBu LUf)(LUb RDb) 3s 12s 3s 2s.

[[FBR^2, U], b^2lr^2u] (24 moves): (FUl UBl BDI DLb DBr FRu DRf LFu UFr URb FLd)(FDr RUf BUr BRd)(BRu LBu LUf)(LUb RDb) 11s 4s 3s 2s.

[[FB^2, RU'], br^2u] (22 moves): (FUl FRu RBu BLu LFu)(FUr BDr)(FRd RBd Rdf ULb RUB BLd BUl LUf DRb LDb)(FDr BDI BUr) 5s 2s 10s 3s.

[[FB^2R, D], $b^2lr'u$] (24 moves): (FUl DRf DBr FDr UFr LUb DF1 DLb URb)(FLu FRd LBu BUl BLd UBr)(FRu RBu Ldf)(BDI RDb) 9s 6s 3s 2s.

[[$FB, R'U$], bl^2d] (22 moves): (FUl UBl BDI DF1 DRf RBu BRd FLd)(FUr

FRd BLd)(FRu BUr LUb URb RDb DLb ULf)(BDr URf) 8s 3s 7s 2s.

[[FR, U^2D^2], brd^2] (22 moves): (FUl RUf DRf RBu)(FUr DFr BDr FRd BLd UBr ULb RUb DRb LDl)(FLu LUf FDI RFu)(FLd BRd) 4s 10s 4s 2s.

[[FB, RU], bl^2u^2d] (24 moves): (FUl DBr BDI BRd RFd URb LBd UFr DRf)(FLu BRu BUI FDI)(FRu BLu DLb FLd RDb)(BUr LUb) 9s 4s 5s 2s.

[[FB, L^2R], fb^2rd^2] (24 moves): (FUr FLu DFr LUf BRu RFu RDf URf)(FLd BRd URb DLb)(FRd DRb BDr UBr ULb BLd)(BLu BDI) 8s 4s 6s 2s.

[[FRB', D'], $b^2l^2r^2d^2$] (24 moves): (FUl LUb BUr FRu FDr RDb BDI)(FUr RDf BDr DLf)(FLd RUf BRd RFd DFI UBI LBd)(LDl RUb) 7s 4s 7s 2s.

[[FB^2R, D^2], $f^2b^2lr^2$] (24 moves): (FUl UFr)(FRu DFI DBr BUr FDr RFd UBI BDI)(BLu DRf DLb URb ULf)(BLd DRb DLf URf ULb) 2s 8s 5s 5s.

[[FB^2R', U^2], b^2ru^2d] (24 moves): (FUl RBu BUr UFr FDr UBI)(FLu BDr)(FRu ULf BLu URb DLb)(FLd LBd BRd RDb RUf LUb BDI) 6s 2s 5s 7s.

[[FB', RU], fbr^2d^2] (24 moves): (FUr DFr LBu UBr BDr FLu)(FRu DRf LDf ULf RUf RBu)(FLd BRd RDb DLb LBd RFd)(LUb URb) 6s 6s 6s 2s.

[[FR, D^2], $bl^2r^2ud^2$] (22 moves): (FUl BUr RBu RDb DLb BRd FLd LUb DRf BLu LDf)(FUr BUI BLd)(FRu FDr BDI)(FRd FDI BDr) 11s 3s 3s 3s.

[[FBR^2, U], bl^2ud] (24 moves): (FUl BDI LBd DLb RFd URb UBI DFI RDb FLd)(FUr UBr ULb RBd)(FLu RFu RDf)(BRu LBu LUf) 10s 4s 3s 3s.

[[FB, R], $blrud^2$] (22 moves): (FUl FRu RBu BLu BUr RUf DBr UBI DRf)(FUr FRd LFd FDI DRb)(FDr DLb LBd)(BRd URb BDI) 9s 5s 3s 3s.

[[FBR^2, U], $bl^2r'u$] (24 moves): (FUl BDI FLd)(FUr BDr URf RFu RDf FLu)(FDI DRb LDl RBd UBr ULb RUb BUI)(BRu LBu LUf) 3s 6s 8s 3s.

[[FB, R], $fbru^2d^2$] (22 moves): (FUl FRu DRf RUf DBr RBu BLu)(FUr FRd LFd DBI RBd RUb DRb)(FLu UBr LUf)(FDr DLb LBd) 7s 7s 3s 3s.

[[FR, U^2D^2], brd'] (22 moves): (FUl RUf DRf RBu)(FUr DFr BDr)(FLu LUf FDI RFu)(FLd RFd BRd LBd LUb URb RDb DLb BUr) 4s 3s 4s 9s.

[[FB^2R, D], b^2l^2ru] (24 moves): (FUl UFr LBd DFI DLb URb UBI LUb)(FLu FRd LBu RDf)(FRu RBu LDf)(FDr DBr BUr BDI RDb) 8s 4s 3s 5s.

[[FB', RU'], bl^2u] (22 moves): (FUl BDI FLd)(FUr FDI BLd BUI URf

$LUf)(FLu RFu BRu LBu)(FRd RBd RDf ULb RUb DRb LDb)$ 3s 6s 4s 7s.
 $[[FR, D^2], b^2lr^2u^2d']$ (22 moves): (FUl BRd LBd URb DRf DLb UFr)(FLu
DLf BRu DRb ULb)(FRu FDr BDI)(FRd UBr LBu FDI BDr) 7s 5s 3s 5s.
 $[[FBR', U'], fb^2l^2d]$ (24 moves): (FUl LUb FLd LBd RDb BDI)(FUr UBr
URf FLu LUf DLf)(FRd BDr RBd)(FDI BRu BUl RUb LDb) 6s 6s 3s 5s.
 $[[FB^2, L'R], br^2u]$ (22 moves): (FUl DF1 BRd LBd)(FUr BDr LDb DFr UBr
ULb RUB DRb)(FLu RFu BRu LBu)(FLd RFd ULf RUf) 4s 8s 4s 4s.
 $[[FBR', U], f^2b^2r^2u]$ (24 moves): (FUl RUf BUr LUb RDb FDr LDf)(FUr
RUB LDb BDr)(FLu RBd RFu DBI)(BUl LUf BRu LBu RDf) 7s 4s 4s 5s.
 $[[FB, L'R], br^2u]$ (22 moves): (FUl DF1 FDr BUr UFr DBr)(FLu RFu BRu
LBu)(FLd RFd BRd LBd)(LUB URb RDb RUf DLb ULf) 6s 4s 4s 6s.
 $[[FBR', U], b^2l^2ud]$ (24 moves): (FUl BDI LFu FRu)(FUr RUB BUl FDI
LDb)(FLd BLu ULf RBu LBd DBr)(FRd DRb UBr ULb RBd) 4s 5s 6s 5s.
 $[[FB, R], lru^2d^2]$ (20 moves): (FUl FRu BLu UBl DRf)(FUr FRd BLd DFr
DRb)(FLu UBr URf BDr BRu)(FLd DF1 URb BDI BRd) 5s 5s 5s 5s.

20 edge pieces, 6 cycles

$[[FB^2, RU'], bl^2u^2]$ (22 moves): (FUl BDI)(FUr LFd)(FLu BRu)(FRu
BLu)(FRd RBd RDf ULb RUB FDI BDr BUl DRb LDb)(BLd LUf) 2s 2s
2s 2s 10s 2s.
 $[[FB^2, R'D], b^2r^2d]$ (22 moves): (FUr RFu BDr)(FLd BDI BLu LUb RBu
RDb LBd BRd RFd)(FDI DLf)(FDr BUr)(BUl URf)(LDb RUB) 3s 9s 2s 2s
2s 2s.
 $[[FB, LR], ru^2d^2]$ (22 moves): (FUl UFr UBl FDr BDI DBr DF1 BUr)(FLu
BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUf DRb LDb URf) 8s 2s 2s 2s 2s
4s.
 $[[F^2R, L^2D^2], blrd]$ (24 moves): (FUl BUr)(FUr BDr)(FLu RFu RBd FRd
LFd BLd LUf)(FDI BUl)(FDr BDI)(BRu DRb ULb RUB LDb) 2s 2s 7s 2s
2s 5s.
 $[[FB, L'R], b^2ru^2]$ (22 moves): (FUl UFr FDr DBr DF1 BUr)(FLu
BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUB RDb ULf RUf URb DLb) 6s
2s 2s 2s 2s 6s.
 $[[FB, R'U], b^2ld^2]$ (22 moves): (FUl UBl BDI DF1 DRf RBu BRd FLd)(FUr
FRd BLd)(FRu URb DLb)(BUr ULf)(BDr URf)(LUB RDb) 8s 3s 3s 2s 2s

2s.

$[[FB^2, R'D], b^2rd^2]$ (22 moves): (FU_r BU_l RF_u UR_f DF_r BDr UBr)(FL_d BL_u BR_d)(FR_d BL_d)(FD_l DL_f)(BR_u DR_b DB_l UL_b)(LD_b RU_b) 7s 3s 2s 2s 4s 2s.

$[[FB^2, RU'], b^2r^2u]$ (22 moves): (FU_l FR_u RB_u BL_u LF_u)(FU_r BDr)(FR_d RD_f)(FDr BD_l BU_r)(BU_l LU_f LD_b RB_d RU_b BL_d)(LU_b RD_b) 5s 2s 2s 3s 6s 2s.

$[[FB, LR], r^2ud']$ (22 moves): (FU_l DF_l FDr UB_l BD_l DBr)(FU_r UBr)(FL_u RF_u BR_u LB_u)(FL_d RF_d BR_d LB_d)(LU_f LD_b)(RU_f RD_b) 6s 2s 4s 4s 2s 2s.

$[[FB^2, R^2U], fb^2r^2u^2]$ (24 moves): (FU_l BR_d)(FU_r BDr)(FL_u DL_f BU_l LU_f BR_u)(FR_u BL_u FDr BD_l BU_r)(FR_d UR_f BL_d RD_f)(LU_b RD_b) 2s 2s 5s 5s 4s 2s.

$[[FB, R'U], bl^2d^2]$ (22 moves): (FU_l BD_l)(FU_r FR_d BL_d)(FR_u BU_r LU_b UR_b RD_b DL_b UL_f)(FL_d DR_f BR_d)(FD_l BR_u BU_l)(BDr UR_f) 2s 3s 7s 3s 3s 2s.

$[[FB, L'R], br^2u^2]$ (22 moves): (FU_l FDr BU_r)(FU_r BDr FD_l)(FL_u BR_u)(FR_u BL_u)(FL_d RF_d BR_d LB_d)(LU_b UR_b RD_b RU_f DL_b UL_f) 3s 3s 2s 2s 4s 6s.

$[[FR, D^2], b^2lru^2d^2]$ (22 moves): (FU_l LB_d BU_r)(FL_u DL_f BR_u DR_b UL_b)(FR_u FDr BD_l)(FL_d UR_b DR_f DL_b BR_d)(FR_d BDr)(FD_l LB_u) 3s 5s 3s 5s 2s 2s.

$[[FB, LR], ru^2d']$ (22 moves): (FU_l UFr DBr DF_l BU_r)(FL_u BR_u)(FR_u BL_u)(FL_d RF_d BR_d LB_d)(FDr UB_l BD_l)(LU_f DR_b LD_b UR_f) 5s 2s 2s 4s 3s 4s.

$[[FB, LR], r^2ud]$ (22 moves): (FU_l DF_l FDr DBr)(FU_r DB_l BU_l UBr)(FL_u RF_u BR_u LB_u)(FL_d LB_d BR_d RF_d)(LU_f LD_b)(RU_f RD_b) 4s 4s 4s 4s 2s 2s.

$[[FR, D^2], fbl^2r'u^2d']$ (24 moves): (FU_l UFr BL_u)(FL_u RD_f)(FR_u UB_l BR_d DL_b FDr BD_l)(FR_d FD_l BDr)(BR_u DR_b DL_f)(BL_d UL_b UR_f) 3s 2s 6s 3s 3s 3s.

$[[FR, D^2], fbl^2r^2d^2]$ (22 moves): (FU_l BU_r FR_u FDr BD_l)(FU_r BU_l BL_d)(FL_d LU_b RU_f)(FR_d FD_l BDr)(BR_u DR_b DL_f RD_f)(BR_d DL_b) 5s 3s 3s 3s 4s 2s.

$[[FB, LR], ru'd']$ (22 moves): (FU_l BU_r DF_l)(FU_r BDr)(FL_u LB_u BR_u RF_u)(FL_d RF_d BR_d LB_d)(FDr UB_l BD_l)(LU_f DR_b LD_b UR_f) 3s 2s 4s 4s

3s 4s.

$[[FB, R], fblrud^2]$ (24 moves): (FUl FRu DRf)(FUr FRd LFd FDI
DRb)(FDr DLb LBd)(BUr ULf BLu)(BUl URf BDr)(BRd URb BDI) 3s 5s
3s 3s 3s 3s.

$[[FB', R], b^2lr^2u'd^2]$ (22 moves): (FUl BDI RUF DRf)(FUr FRd DRb)(FLu
BUl BRu RFu)(FLd FDr DLb)(BUr BRd URb)(BLd BDr ULb) 4s 3s 4s 3s
3s 3s.

20 edge pieces, 8 cycles

$[[FB^2, RU'], b^2l^2u^2]$ (22 moves): (FUl BDI)(FUr LFd)(FLu BRu)(FRu
BLu)(FRd Rdf)(FDI BDr BUl LDb RBd RUb)(BLd LUf)(LUb RDb) 2s 2s
2s 2s 2s 6s 2s 2s.

$[[FR'B, U^2], b^2l^2r^2d]$ (24 moves): (FUl BUr)(FUr BUl)(FLu URf)(FLd LBd
DRf)(FRd LUf RBd RUb LDb)(FDI BDr)(FDr BDI)(LUb RDb) 2s 2s 2s 3s
5s 2s 2s 2s.

$[[FB, LR], r^2u^2d^2]$ (22 moves): (FUl FDr BDI BUr)(FUr BUl BDr
FDI)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUf LDb)(RUF RDb) 4s
4s 2s 2s 2s 2s 2s 2s.

$[[FB^2, RU'], b^2r^2u^2]$ (22 moves): (FUl RBu LFu)(FUr BDr)(FRu BLu)(FRd
Rdf)(FDr BDI BUr)(BUl LDb RBd RUb)(BLd LUf)(LUb RDb) 3s 2s 2s 2s
3s 4s 2s 2s.

$[[FB, L'R], b^2r^2u^2]$ (22 moves): (FUl FDr BUr)(FUr BDr FDI)(FLu
BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUb RDb RUF)(LUf RUb LDb) 3s
3s 2s 2s 2s 2s 3s 3s.

20 edge pieces, 10 cycles

$[[FR^2, D^2B'], fblr^2]$ (24 moves): (FUl UBl)(FUr BDr)(FRu BRd)(FRd
UBr)(FDI DBI)(FDr RBu)(LUb RUf)(LUf Rdf)(LDb RUb)(Ldf RDb) 2s
2s 2s 2s 2s 2s 2s 2s 2s.

21 edge pieces, 1 cycle

$[[FB, RU'], brud']$ (24 moves): (FUr Rdf ULb LFd FRd DFr RFu BRu LBu
UBr RUb DRb LDb RBd URf BDr BUl LUf FLu BLd DBI) 21s.

21 edge pieces, 3 cycles

$[[FB, RU'], bl'u^2d^2]$ (24 moves): (FUl DF1 BRd FLd LFu RBu RDb DLb LBd BUr RFd UFr DRf LUb UBl FRu BLu)(BDr LUf)(BDl URb) 17s 2s 2s.

$[[FB, RU'], br'u^2d^2]$ (24 moves): (FUr RDf ULb DBl RUb DRb LDb BLd BDr LUf DFr URf LFd RBd BRu FLu)(FRu BLu UBl)(FRd UBr) 16s 3s 2s.

$[[FB, RU'], blu^2d]$ (24 moves): (FUl UBl FRu BLu BDI BRd RFd UFr DRf LUb BUr DF1 RDb DLb FLd)(FLu BRu BLd RUb)(BDr LUf) 15s 4s 2s.

$[[FB, RU'], blu^2d']$ (24 moves): (FUl UBl FRu BLu BDI BUr URb LFu RBu RFd UFr DRf LUb FLd)(FDl DRb LDb RBd BLd)(BDr LUf) 14s 5s 2s.

$[[FB, RU'], bl^2u^2d^2]$ (24 moves): (FUl BDI URb BRd FLd RDb DLb LBd BUr RFd UFr DRf LUb)(FLu BRu BUl RFu LBu FDI)(BDr LUf) 13s 6s 2s.

$[[FB, RU'], br'ud^2]$ (24 moves): (FUr RDf ULb DBl RUb DRb LDb BLd BDr BUl LUf FLu)(FRu RBu BLu FDr RUf FLd BRd)(FRd UBr) 12s 7s 2s.

$[[FB, RU'], bl'u'd^2]$ (24 moves): (FUl DF1 BRd FLd FRu LFu BLu ULf)(FUr RDf ULb BUl BDr BRu DRb LDb BLd UBr FRd)(BDl URb) 8s 11s 2s.

$[[FB, RU'], blu^2d^2]$ (24 moves): (FUl UBl FRu BLu BDI URb LFu RBu BRd FLd)(FUr RDf ULb FDI DRb LDb BLd UBr FRd)(BDr LUf) 10s 9s 2s.

$[[FBR^2, U], bl^2r^2u]$ (24 moves): (FUl BDI FLd)(FUr DFr URf UBr ULb RUb BUl FDI DRb LDb RBd BDr RFu RDf FLu)(BRu LBu LUf) 3s 15s 3s.

$[[FB^2, RU], bru'd']$ (24 moves): (FUl DLb BRd UFr RUf RBu FRu LFu BDI ULf DBr BUr LUb URb)(FLd RFd LBd RDb)(FDr BLu DRf) 14s 4s 3s.

$[[FB, RU^2], b^2rud^2]$ (24 moves): (FUl BLu BUr UFr RFd RDb LUb LBd FDr UBl DRf RUf DBr)(FLu RFu BRu)(FLd URb DLb BRd BDI) 13s 3s 5s.

$[[FB, RU'], br'u^2d']$ (24 moves): (FUr RDf ULb LFd FRd UBr RUb DRb LDb RBd BRu FLu)(FRu BLu UBl)(FDr RUf LBd BDI DBr ULf) 12s 3s 6s.

$[[FB, RU^2], b^2rud]$ (24 moves): (FUl BLu BUr UFr BDI BRd FDr UBl DRf RUf DBr)(FLu RFu BRu)(FLd URb DLb LBd RFd RDb LUb) 11s 3s 7s.

$[[FB, L^2R], f^2b^2rd]$ (24 moves): (FUr DBl FLu LBu DFr DLf BRu

URf)(FRu DRf ULf)(FLd LBd BRd URb DLb RFd RDb DBr BUr LUb)
8s 3s 10s.

[[FB, RU'], $bl'ud'$] (24 moves): (FUl DF1 RFd UFr DRf LUb FLd BLu
DBr)(FLu RFu BRu DRb LDb RBd BLd BUl LUf)(BUr URb BDI) 9s 9s
3s.

[[FB^2, RU'], $fb'ru$] (24 moves): (FUl DBr BUr UFr FDr FRu DRf BRd RFd
RDb BLu LFu BDI)(BUl DLf RUb BLd)(LUB DLb RUf ULf) 13s 4s 4s.

[[FB^2, RU], $br'u'd'$] (24 moves): (FUl DLb BRd DBr FDr ULf BDI BLu DRf
BUr LUb URb)(FUr URf BRu RFu FLu)(FLd RFd LBd RDb) 12s 5s 4s.

[[FB, RU'], $b^2lu'd^2$] (24 moves): (FUl UBl DBr RBu BRd FLd)(FUr RUB
RFu FLu LBu LUf DBI DRb ULb FDI LDb)(FRd Rdf BLd UBr) 6s 11s 4s.

[[FB^2, RU], $blu'd'$] (24 moves): (FUl DLb BRd BUr LUb DBr RFd LBd
RDb FLd)(FUr URf BRu RFu FLu LBu Rdf)(FDl RUB BUl DBI) 10s 7s
4s.

[[FB, RU'], $blud^2$] (24 moves): (FUl UBl ULf LFu FRu RBu BRd FLd)(FUr
RDf ULb FDI DRb LDb BLd UBr FRd)(BLu DBr BDI URb) 8s 9s 4s.

[[FB, RU'], $blud'$] (24 moves): (FUl UBl ULf LFu FRu RBu RFd UFr DRf
LUb FLd)(FDI DRb LDb RBd BLd)(BUr URb BLu DBr BDI) 11s 5s 5s.

[[$FB^2, L'R$], blr^2d^2] (24 moves): (FUl UBl DRf LDf DF1)(FUr BRu BDr
LDb DFr LBu UBr ULb RUB DRb)(FLd LBd RFd ULf RUf BRd) 5s 10s
6s.

[[FB, RU'], $br'ud$] (24 moves): (FUr Rdf ULb BDr BUl LUf FLu)(FRu
RBu BLu FDr RUf RFd BUr BDI BRd)(FLd LBd URb RDb DLb) 7s 9s 5s.

[[FB, LR], $br'u^2d^2$] (24 moves): (FUl DBr DF1 FDr BDI UFr UBl BUr)(FLu
RFu LBu BLd FRd LFd RBd BRu)(LUB URb RDb ULf RUf) 8s 8s 5s.

[[FB, RU'], $blu'd^2$] (24 moves): (FUl UBl DBr RBu BRd FLd)(FUr Rdf
ULb FDI DRb LDb BLd UBr FRd)(FLu LBu LUf DBI RUB RFu) 6s 9s 6s.

[[FB, LR], br^2ud^2] (24 moves): (FUl DF1 FDr BDI BUr UFr UBl DBr)(FRu
RBu BLu LBd RFd FLd BRd)(LUB URb RDb RUf DLb ULf) 8s 7s 6s.

[[FB^2, RU], $blud'$] (24 moves): (FUl RDb UBl BDI DF1 URb FLd)(FUr URf
FLu RFu BRu LBu Rdf)(FRd BLd LDb RBd UBr ULb BDr) 7s 7s 7s.

21 edge pieces, 5 cycles

$[[FB^2, RU], br'ud^2]$ (24 moves): (FUl RDb)(FUr FLu)(FRu RBu BLu BUr
LUb URb RFd FLd BRd DBr FDr ULf BDI)(BLd LDb)(RUf DRf) 2s 2s
13s 2s 2s.

$[[FB^2, RD], br'u^2d']$ (24 moves): (FUl RDb BLu FRu UBl FLd RUf FDr
Ufr RFd BRd URb)(FLu DBl BRu)(FDl ULb)(BUr DBr)(BLd LDb) 12s
3s 2s 2s 2s.

$[[FB^2, RU], brud^2]$ (24 moves): (FUl RDb)(FUr FLu DBl LUf BDr UBr
ULb RUB FRd LFd RBd)(FRu RBu BLu FDr)(BLd LDb)(RUf DRf) 2s
11s 4s 2s 2s.

$[[FB^2, R'U], b^2ru^2d]$ (24 moves): (FUl DRf)(FUr URf ULb DRb RBd FRd
LFd BLd DFr BRu)(FLu DBl LUf BDr UBr)(FRu URb)(BLu DLb) 2s 10s
5s 2s 2s.

$[[FB^2, L'R], b^2lu^2d']$ (24 moves): (FUl LBd)(FUr DFr FLu BRu RFu
LBu)(FLd ULf RFd RUf BRd UBl DRf Ldf DFl)(LUb RDb)(LDb RUB) 2s
6s 9s 2s 2s.

$[[FB^2, RU], br^2ud^2]$ (24 moves): (FUl RDb)(FUr FLu LUf RFu BRu LBu
BDr)(FLd BRd FDr BDI BUr LUb URb RFd)(BLd LDb)(RUf DRf) 2s 7s
8s 2s 2s.

$[[FB, L^2R], blru^2]$ (24 moves): (FUl FLd UBl RDb DBr LBd BUr DLb RFd
BRd URb)(FUr DFr URf)(FLu BRu)(FRu BLu)(FDl Rdf BDI) 11s 3s 2s
2s 3s.

$[[FB^2, RU], b^2lu^2d^2]$ (24 moves): (FUl RFd BUr LBd UBl BDI DFl RDb
DLb FLd)(FUr RFu LBu)(FLu BRu)(BRd URb LUb DBr)(RUf DRf) 10s
3s 2s 4s 2s.

$[[FB^2, RU], bl'r^2d^2]$ (24 moves): (FUl DFl BRd FDr UBl)(FUr LBu BDr
RUB DRb LDb BLd FRd LFd)(FLu LUf)(BUr LUb BDI)(RUf DRf) 5s 9s
2s 3s 2s.

$[[FB, RU'], bl^2u^2d]$ (24 moves): (FUl BDI BRd RFd Ufr DRf LUb
BUr)(FLu BRu BUl RFu LBu FDI)(FLd RDb DLb)(BLd RUB)(BDr LUf)
8s 6s 3s 2s 2s.

$[[FB^2, RU], b^2l^2ud]$ (24 moves): (FUl DLb RFd BUr FLd RDb BDI)(FUr
Rdf FLu RFu BRu LBu URf)(FDl BDr BUl)(BRd URb)(BLd ULb) 7s 7s
3s 2s 2s.

$[[FB^2, L^2R], bl^2r^2u^2]$ (24 moves): (FUl FLd BDI DRf)(FUr BDr LDb FRd

U_Br R_Bd D_Fr R_Ub D_Rb)(F_Lu B_Ru F_Dl B_Ul)(F_Ru B_Lu)(B_Ld U_Rf) 4s 9s
4s 2s 2s.

[[$FB, L'R$], bru^2d^2] (24 moves): (F_Ul U_Fr U_Bl F_Dr B_Dl D_Br D_Fl B_Ur)(F_Lu
B_Ru)(F_Ru B_Lu)(F_Ld L_Bd B_Rd R_Fd)(L_Ub U_Rb R_Db U_Lf R_Uf) 8s 2s 2s 4s
5s.

[[$FB, L'R$], b^2ru^2d] (24 moves): (F_Ul U_Fr B_Dl U_Bl D_Br D_Fl B_Ur)(F_Lu
B_Ru)(F_Ru B_Lu)(F_Ld R_Fd B_Rd L_Bd)(L_Ub R_Db U_Lf R_Uf U_Rb D_Lb) 7s 2s
2s 4s 6s.

[[FB^2, L^2R], $b^2lr^2u^2$] (24 moves): (F_Ul F_Ld U_Bl D_Rf L_Fu R_Bu D_Fl)(F_Ur
B_Dr U_Lb F_Rd D_Rb)(F_Ru B_Lu)(F_Dr U_Rb D_Lb B_Ur B_Rd)(B_Ld U_Rf) 7s 5s
2s 5s 2s.

[[$FB^2, L'R$], b^2lu^2d] (24 moves): (F_Ul R_Fd R_Uf F_Ld U_Lf L_Bd)(F_Ur R_Fu
L_Bu F_Lu B_Ru D_Fr)(F_Dl R_Bd B_Ul R_Df D_Lf)(L_Ub R_Db)(L_Db R_Ub) 6s 6s
5s 2s 2s.

[[FRB', D^2], $br^2u^2d^2$] (24 moves): (F_Ur F_Dl B_Dr)(F_Lu D_Lf B_Ru L_Bu D_Rb
L_Db R_Bd L_Fd U_Lb R_Df)(F_Ru U_Rb)(F_Rd B_Ld U_Rf)(F_Dr B_Ur B_Dl) 3s 10s
2s 3s 3s.

[[FBR^2, U], $b^2l^2r^2u$] (24 moves): (F_Ul B_Dl F_Ld)(F_Ur R_Ub B_Ul F_Dl L_Db
B_Dr R_Fu R_Df F_Lu)(F_Dr R_Uf B_Ur B_Rd)(B_Ru L_Bu L_Uf)(L_Ub R_Db) 3s 9s
4s 3s 2s.

[[FB, RU^2], $b^2r^2ud^2$] (24 moves): (F_Ul B_Lu U_Fr R_Fd R_Db L_Ub L_Bd
D_Br)(F_Lu R_Fu B_Ru)(F_Ld U_Rb D_Lb B_Rd B_Dl)(F_Dr D_Rf B_Ur)(B_Ul U_Rf)
8s 3s 5s 3s 2s.

[[FB, RU^2], b^2r^2ud] (24 moves): (F_Ul B_Lu U_Fr B_Dl B_Rd D_Br)(F_Lu R_Fu
B_Ru)(F_Ld U_Rb D_Lb L_Bd R_Fd R_Db L_Ub)(F_Dr D_Rf B_Ur)(B_Ul U_Rf) 6s 3s
7s 3s 2s.

[[$FB, R'U$], fb^2l^2d'] (24 moves): (F_Ul B_Dl)(F_Ur B_Dr L_Fd U_Rf)(F_Ru U_Rb
D_Lb)(F_Rd D_Rb U_Lb R_Df)(F_Dl B_Ru B_Ul R_Bd B_Ld L_Uf U_Br D_Lf) 2s 4s 3s
4s 8s.

[[FB^2, RU], b^2lud] (24 moves): (F_Ul D_Lb R_Fd B_Ur F_Ld)(F_Ur R_Df F_Lu
R_Fu B_Ru L_Bu U_Rf)(F_Dl D_Rb B_Ul D_Bl)(B_Rd U_Rb)(B_Ld U_Lb B_Dr) 5s 7s
4s 2s 3s.

[[FB, LR], br^2ud'] (24 moves): (F_Ul D_Fl F_Dr U_Bl B_Dl D_Br)(F_Ur
U_Br)(F_Ru R_Bu B_Lu B_Rd)(F_Ld R_Fd L_Bd)(L_Ub U_Rb R_Db R_Uf D_Lb U_Lf)

6s 2s 4s 3s 6s.

$[[FB^2R, D^2], b^2rud]$ (24 moves): (FU_r BR_u)(FL_u RU_b RD_f LD_b LB_u)(FR_u DF_l BD_l FD_r DBr BU_r)(FL_d UB_l RF_d)(BR_d LD_f LB_d RD_b LU_b) 2s 5s 6s 3s 5s.

$[[FB^2, RU], fb^2r^2u]$ (24 moves): (FU_l DL_b BR_d UR_b LB_d LU_b RD_b)(FU_r BDr)(FL_u DL_f BU_l LB_u)(FR_u DR_f RU_f UL_f)(FR_d DFr DB_l UBr) 7s 2s 4s 4s 4s.

$[[FB, RU'], b^2l^2u^2d^2]$ (24 moves): (FU_l BD_l RD_b LU_b)(FU_r RU_b RB_d LF_d LD_b)(FL_u BR_u BU_l RF_u LB_u FD_l)(FR_d RD_f BL_d UBr)(BDr LU_f) 4s 5s 6s 4s 2s.

$[[FB^2, RU], bl^2r^2u']$ (24 moves): (FU_l DL_b RF_d BR_d FDr)(FU_r BDr BU_l FD_l)(FL_u LU_f LB_u BR_u RF_u)(FL_d UR_b BD_l BU_r LU_b)(BL_d DR_b) 5s 4s 5s 5s 2s.

$[[FB, R], b^2lrud^2]$ (22 moves): (FU_l FR_u RB_u BL_u BU_r RU_f DBr UB_l DR_f)(FU_r FR_d DR_b)(FL_d DF_l DL_b)(FDr LU_b LB_d)(BR_d UR_b BD_l) 9s 3s 3s 3s 3s.

$[[FR'B, U'], b^2l^2r^2u]$ (24 moves): (FU_l BR_d BD_l RU_f)(FU_r BDr LD_b FD_l UL_b DR_b BU_l RU_b)(FL_u RF_u LU_f)(FL_d RB_u BL_u)(FDr DR_f BU_r) 4s 8s 3s 3s 3s.

$[[FB, R], fb^2ru^2d^2]$ (22 moves): (FU_l FR_u DR_f RU_f DBr RB_u BL_u)(FU_r FR_d DR_b)(FL_u UBr LU_f)(FL_d BD_l BR_d UR_b DL_b)(FDr LU_b LB_d) 7s 3s 3s 5s 3s.

$[[FB^2, L'R], bl^2r'd^2]$ (24 moves): (FU_l BD_l DR_f)(FU_r BR_u UBr LD_b DFr LB_u)(FL_d LB_d RF_d UL_f RU_f BR_d)(FD_l BU_l DL_f)(LU_b UR_b RD_b) 3s 6s 6s 3s 3s.

$[[FB, L'R], br'u'd^2]$ (24 moves): (FU_l FDr BD_l UFr UB_l BU_r DF_l)(FL_u LB_u BR_u RF_u)(FL_d LB_d BR_d RF_d)(LU_b UR_b RD_b)(LU_f LD_b UR_f) 7s 4s 4s 3s 3s.

$[[FBR', U'], f^2b^2r^2u]$ (24 moves): (FU_l LU_b RD_b)(FU_r LU_f FL_u RF_u RD_f BDr)(FL_d DL_b UB_l UR_b)(FDr BR_d BU_r RU_f LD_f)(BR_u LB_u DB_l) 3s 6s 4s 5s 3s.

$[[FB, R], blru^2d^2]$ (22 moves): (FU_l FR_u BL_u UB_l DR_f)(FU_r FR_d LF_d FD_l DR_b)(FL_u UBr UR_f BDr BR_u)(FDr DL_b LB_d)(BR_d UR_b BD_l) 5s 5s 5s 3s 3s.

$[[FB, L'R], b^2rud']$ (24 moves): (FUl DF1 UFr DBr)(FLu RFu BRu LBu)(FLd LBd BRd RFd)(FDr UBl BDI)(LUb RDb ULf RUf URb DLb) 4s 4s 4s 3s 6s.

$[[FB, L'R], bru'd^2]$ (24 moves): (FUl BUr DF1)(FUr BUl DFr DBI BDr)(FLu LBu BRu RFu)(FLd LBd BRd RFd)(LUb URb RDb ULf RUf) 3s 5s 4s 4s 5s.

$[[FB^2R, D'], fb'rud]$ (26 moves): (FUr RDf BRu RBd)(FLu BUl LBu FRd LFd)(FRu FDr BUr LBd)(FDI DBI DLf URf)(BDr LDb DRb RUB) 4s 5s 4s 4s 4s.

21 edge pieces, 7 cycles

$[[FR'B, U^2], bl^2r^2ud^2]$ (26 moves): (FUl BUr)(FUr BUl)(FLu LFd RBd URf ULb BRu LBu RUB DRb)(FRu DLb)(FDI BDr)(FDr BDI)(LUf RDf) 2s 2s 9s 2s 2s 2s 2s.

$[[FB^2, R'U], f^2b^2r^2u^2]$ (24 moves): (FUl ULf RBu FDr BDI BUr LFu DRf)(FUr BDr)(FRu URb)(FRd URf DLf)(BUl RBd)(BLu DLb)(LUb RDb) 8s 2s 2s 3s 2s 2s 2s.

$[[FBR', U^2], fbr'ud]$ (26 moves): (FUl UBl UFr BUr DBr RUf LUb)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(FDr URb)(BDI ULf LDf RDb) 7s 2s 2s 2s 2s 2s 4s.

$[[FR^2, U^2D^2], b^2lr^2d']$ (24 moves): (FUl FRu UBl BDI DF1 LFu)(FUr FRd UBr LFd RBd)(FDr DBr)(LUb RDb)(LUf RDf)(LDb RUB)(LDf RUf) 6s 5s 2s 2s 2s 2s 2s.

$[[FB, L'R], br'u^2d']$ (24 moves): (FUl DBr DF1 FDr UBl BDI BUr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUb URb RDb)(LUf LDf URf) 7s 2s 2s 2s 2s 3s 3s.

$[[FB^2, R'U], b^2r^2u^2d^2]$ (24 moves): (FUl DRf)(FUr ULb DRb BDr)(FLu LUf BRu DFr DBI UBr)(FRu URb)(FLd BRd)(FRd BLd URf)(BLu DLb) 2s 4s 6s 2s 2s 3s 2s.

$[[FB, L'R], bru^2d']$ (24 moves): (FUl UFr DBr DF1 BUr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(FDr UBl BDI)(LUb URb RDb ULf RUf) 5s 2s 2s 2s 3s 5s.

$[[FB^2, R'D'], f^2b^2ru^2]$ (24 moves): (FUl BDI)(FUr UBr)(FLu BLd BRu DRb ULb)(FRu LDf UBl BLu)(FDI LUf RBd RDf)(FDr DBr)(LDb RUB)

2s 2s 5s 4s 4s 2s 2s.

$[[FB^2, R'U'], br'u^2d^2]$ (24 moves): (FUl DRf)(FUr LDl FLu)(FRu RDl
BUr ULf DBr FDr)(FLd BRd)(FRd BLd)(BUl RUl ULb)(BRu LBu DBl)
2s 3s 6s 2s 2s 3s 3s.

$[[FB, L'R], br'u'd']$ (24 moves): (FUl BUr DF1)(FUr BDr)(FLu LBu BRu
RFu)(FLd BRd)(FRd BLd)(FDr UBl BDI)(LUb URb RDl ULf RUf) 3s 2s
4s 2s 2s 3s 5s.

$[[FB^2, R'U'], f^2b^2r^2d]$ (24 moves): (FUr BUl ULb BDr)(FLu LBu)(FRu
URb RBu DLl)(FLd LBd BRd LDf)(FRd URf)(FDr BDI BUr)(LUf RDf)
4s 2s 4s 4s 2s 3s 2s.

$[[FR, D^2], fbl^2r^2u^2d^2]$ (24 moves): (FUl LBd UFr)(FLu RDf)(FRu FDr
BDI)(FLd LUl RUf)(FRd UBr LBu FDI BDr)(BRu DRl DLf)(BRd DLl)
3s 2s 3s 3s 5s 3s 2s.

$[[FB, L'R], br'u'd']$ (24 moves): (FUl DF1 DBr)(FLu RFu BRu LBu)(FLd
BRd)(FRd BLd)(FDr UBl BDI BUr)(LUb URb RDl)(LUf LDl URf) 3s 4s
2s 2s 4s 3s 3s.

$[[FR, D^2], fbl^2r^2u^2d']$ (24 moves): (FUl BUr BLu)(FUr BUl RBd LDl)(FLu
RDf)(FRu FDr BDI)(FRd FDI BDr)(BRu DRl DLf)(BLd ULb URf) 3s 4s
2s 3s 3s 3s 3s.

$[[FB, R], fb^2lrud^2]$ (24 moves): (FUl FRu DRf)(FUr FRd DRl)(FLd DF1
DLl)(FDr LUl LBd)(BUr ULf BLu)(BUl URf BDr)(BRd URl BDI) 3s 3s
3s 3s 3s 3s 3s.

21 edge pieces, 9 cycles

$[[FBR^2, U^2], fbrud]$ (26 moves): (FUl BUr UFr FDr UBl)(FLu BRu)(FRu
BLu)(FLd BRd)(FRd BLd)(LUl RUf)(LUf RDf)(LDl RUl)(LDf RDl) 5s
2s 2s 2s 2s 2s 2s 2s 2s.

$[[FR^2, U^2F], fbl^2r^2d]$ (26 moves): (FUl FLd)(FUr BDr FLu)(FRd DFr)(BUr
BRd)(BUl DBl BRu BLd)(LUl RUf)(LUf RDf)(LDl RUl)(LDf RDl) 2s
3s 2s 2s 4s 2s 2s 2s 2s.

$[[FR^2, U^2D^2], b^2l^2r^2d]$ (24 moves): (FUl FRu BDI)(FUr LFd UBr)(FLu BUl
FDI)(FRd BDr)(FDr LBd)(LUl RDl)(LUf RDf)(LDl RUl)(LDf RUf) 3s
3s 3s 2s 2s 2s 2s 2s 2s.

22 edge pieces, 2 cycles

[[FB, RU], fb^2ud] (24 moves): (FUl LFu FRu DRf BDI BRd RFd BUr FLd LBd UFr RUf ULf RBu BLu DBr LUb URb DLb RDb)(BUl DLf) 20s 2s.

[[FB, RU'], blr^2u^2] (24 moves): (FUl UBl FRu BLu BDI DF1 RDb DLb RFd DBr ULf UFr DRf LUb URb LFu RUf RBu FLd)(FDr BRd BUr) 19s 3s.

[[$FB, R'U$], $blrd'$] (24 moves): (FUl UBl BDI DF1 DRf RBu RFd BRd DLb ULf FRu UFr BUr LUb URb RDb DBr FLd)(FLu BLd URf DFr) 18s 4s.

[[FB, RU'], $blr'u^2$] (24 moves): (FUl UBl FRu BLu BDI DF1 RDb DLb RFd BUr DBr ULf FDr RUf BRd RBu FLd)(FUr Rdf ULb RUB FLu) 17s 5s.

[[FB, RU'], $blru$] (24 moves): (FUl UBl ULf LFu BRd RUf DBr BDI DF1 RDb DLb RFd FDr FRu RBu FLd)(FUr Rdf ULb RUB LBu UBr) 16s 6s.

[[FB, RU'], $blr'u$] (24 moves): (FUl UBl ULf LFu UFr DRf LUb URb BLu FDr RUf BRd FRu RBu FLd)(FRd UBr BDr DBl FDI DRb LDl) 15s 7s.

[[FB, RU'], $blru'$] (24 moves): (FUl UBl BUr UFr DRf LUb URb FRu LFu BRd RUf DBr RBu FLd)(FRd DFr LBu LUf DBl FDI DRb LDl) 14s 8s.

[[FB, RU'], $fbud'$] (24 moves): (FUl RBu BLu DBr UBl LDf DLb BRd LBd BDI BUr URb RDb)(FUr URf LUf FLu RFu Rdf ULb LFd FRd) 13s 9s.

[[FB, RU'], $blru^2$] (24 moves): (FUl UBl FRu BLu BDI DF1 RDb DLb RFd FDr RBu FLd)(FUr Rdf ULb RUB FLu RBd URf BDr LUf UBr) 12s 10s.

[[FB, RU], $fblr$] (24 moves): (FUl UBl LDf BDI DF1 RDb DLb RFd URb RBu FLd)(FUr DFr FLu RBd LUf RFu Rdf URf BDr UBr ULb) 11s 11s.

22 edge pieces, 4 cycles

[[FB, RU], fb^2ud^2] (24 moves): (FUl LFu FRu DRf RFd BUr LBd RUf ULf RBu BLu DBr LUb URb DLb RDb)(FUr DBl)(FLd BRd)(BUl DLf) 16s 2s 2s 2s.

[[FB, RU'], $b^2lr^2u^2$] (24 moves): (FUl UBl FRu BLu BDI DF1 DLb DBr ULf UFr URb LFu RUf RBu FLd)(FRd Rdf)(FDr BRd BUr)(LUb RDb) 15s 2s 3s 2s.

[[FB, RU'], b^2lru] (24 moves): (FUl UBl ULf LFu BRd RUf DBr BDI DF1 DLb FDr FRu RBu FLd)(FUr RUB LBu UBr)(FRd Rdf)(LUb RDb) 14s 4s 2s 2s.

[[FB, RU'], $b^2lr'u$] (24 moves): (FUl UBl ULf LFu UFr URb BLu FDr RUf

BRd FRu RBu FLd)(FRd RDf)(FDl LDb UBr BDr DBl)(LUb RDb) 13s 2s
5s 2s.

[[FB, RU'], b^2lru'] (24 moves): (FUl UBl BUr UFr URb FRu LFu BRd RUf
Dbr RBu FLd)(FRd RDf)(FDl LDb DFr LBu LUf DBl)(LUb RDb) 12s 2s
6s 2s.

[[FB, RU], $f^2b^2ud^2$] (24 moves): (FUl LFu FRu UBl RBu BLu Dbr LUb
URb DLb RDb)(FUr DBl)(FLd BRd)(FRd UBr BLd LUf URf DLf RDf)
11s 2s 2s 7s.

[[FB, RU], $fb'ud$] (24 moves): (FUl LFu FRu DRf Bdl BRd RFd
RDb)(FUr URf LUf BRu LBu BDr RUb ULb LFd BLd)(BUr DLb)(BUl
DLf) 8s 10s 2s 2s.

[[FB, RU], $fbud$] (24 moves): (FUl LFu FRu DRf Bdl BRd RFd URb
RDb)(FUr URf LUf BRu LBu BDr LDb LFd BLd)(BUr LUb)(BUl DLf) 9s
9s 2s 2s.

[[FB, RU'], $f^2b^2ud^2$] (24 moves): (FUl RUf Ldf)(FUr RUb LDb)(FLu RFu
ULb DBl DRb BRu LBu BDr BUl RDf BLd UBr FRd LUf)(FLd BRd) 3s
3s 14s 2s.

[[FB, RU'], bl^2rd'] (24 moves): (FUl Bdl)(FUr UBr ULb RUb DRb BDr
LFd RDf FRd Rbd LDb LUf RFu)(FLu BLd URf DFr)(FDl BRu BUl) 2s
13s 4s 3s.

[[FB, RU'], $bl^2r^2d^2$] (24 moves): (FUl Bdl)(FUr FRd BLd BDr Urf)(FLu
LDb LUf RFu DFr LFd RDf Rbd UBr ULb RUb DRb)(FDl BRu BUl) 2s
5s 12s 3s.

[[FB, RU'], bl^2r^2u] (24 moves): (FUl Bdl)(FUr RDf ULb RUb LFd DRb
LDb FRd BDr Fdl LBu)(FLu URf RFu BRu BUl LUf)(FDr BRd BUr) 2s
11s 6s 3s.

[[FB, RU'], $bl^2r^2u^2$] (24 moves): (FUl Bdl)(FUr RDf ULb RUb LFd DRb
LDb FRd BDr LUf)(FLu URf BRu BUl RFu LBu Fdl)(FDr BRd BUr) 2s
10s 7s 3s.

[[FB, RU'], fb^2ud^2] (24 moves): (FUl RBu BLu Dbr UBl Ldf LUb Bdl
RDb)(FUr RUb LDb)(FLu RFu RDf BLd UBr FRd URf LUf)(FLd BRd)
9s 3s 8s 2s.

[[FB^2, RU], $lr'u^2d$] (24 moves): (FUl BRd RFd FLd)(FUr RDf RFu LBu
URf UBr BDr BLd BUl DBl BRu FLu)(FDl ULb DFr LUf)(RUb DRb) 4s

12s 4s 2s.

$[[FB, RU], fblr^2]$ (24 moves): (FUl UBl LDf BDI DF1 RD_b DL_b RF_d UR_b RB_u FL_d)(FU_r BDr)(FL_u LU_f RF_u RD_f UR_f)(FDr BR_d BU_r LU_b) 11s 2s 5s 4s.

$[[FB^2, L'R], bl^2u'd^2]$ (24 moves): (FUl RF_d UL_f RU_f BR_d UBl LDf DF1 BDI DR_f)(FU_r RF_u FL_u LB_u DFr BR_u)(FL_d LB_d)(LU_b UR_b RD_b DL_b) 10s 6s 2s 4s.

$[[FB^2, RU], fb^2r^2u']$ (24 moves): (FUl LU_b RD_b LB_d DL_b BR_d UR_b)(FU_r BDr)(FL_u DL_f BUl RF_u RD_f UR_f LU_f LB_u BR_u)(FR_d DFr DBl UBr) 7s 2s 9s 4s.

$[[FB^2, RD], fb^2l'd]$ (24 moves): (FUl DF1 RF_d RU_f LB_d BR_d BDI UBl)(FU_r BDr LU_f BR_u RD_f LB_u UBr LF_d)(FDr LDf)(LU_b UR_b DL_b RD_b) 8s 8s 2s 4s.

$[[FB^2, RD], fb^2ru]$ (24 moves): (FUl FR_u LU_b UR_b BDI)(FU_r DFr DL_f BDr UBr)(FL_u LD_b DR_b BL_d BUl BR_u RD_f UR_f LU_f LB_u)(FDl RB_d) 5s 5s 10s 2s.

$[[FB^2, RU], fb'lr]$ (24 moves): (FUl UBl RB_u FR_u DR_f RU_f UL_f DBr FL_d)(FU_r DFr FL_u FDl LD_b)(FR_d DR_b RU_b UL_b UBr RB_d)(BDl LDf) 9s 5s 6s 2s.

$[[FB^2, RU], fb^2r'u^2]$ (24 moves): (FUl LB_d)(FU_r UBr FR_d BDr DFr DL_f BUl FL_u)(FR_u DR_f RU_f UL_f BDI RB_u BL_u)(BR_d UR_b LU_b RD_b DL_b) 2s 8s 7s 5s.

$[[FB, R'U], fb^2u^2d]$ (24 moves): (FUl FR_u UR_b BDI DL_b BL_u)(FU_r LU_f UBr DL_f BUl LF_d BL_d BDr)(FL_u BR_u)(FR_d DR_b UL_b RD_f UR_f RB_d) 6s 8s 2s 6s.

$[[FB^2, RU'], b^2lu'd^2]$ (24 moves): (FUl UBl RF_d DR_f LB_d DL_b FL_d)(FU_r BDr RB_d RU_b LU_f DBl FDl)(FL_u LB_u DR_b UL_b BR_u RF_u)(BU_r RU_f) 7s 7s 6s 2s.

$[[FB, RU'], f^2b^2lr^2]$ (24 moves): (FUl RU_f LF_u LDf UBl BDI DF1 DL_b DBr UFr UR_b RB_u FL_d)(FR_u LU_b RD_b)(FR_d LU_f RD_f)(FDr BR_d BU_r) 13s 3s 3s 3s.

$[[FB, L^2R], b^2lru]$ (24 moves): (FUl LB_d FL_d BU_r LU_b RF_d RD_b DBr UBl DL_b BR_d UR_b)(FU_r DFr UR_f)(FL_u RF_u BR_u LB_u)(FDl RD_f DBl) 12s 3s 4s 3s.

$[[FB, RU'], fb^2l^2r^2]$ (24 moves): (FUl FRu DRf RFd RUf LFu ULf LDf
 LUb RDb BDI)(FUr RUb LFd LDb BDr)(FDl BRu BUI)(FDr BRd BUr)
 11s 5s 3s 3s.

$[[FB, RU'], f^2b^2ud']$ (24 moves): (FUl RUf LDf)(FUr RUb LDb)(FLu RFu
 ULb LFd FRd LUf)(BUr RDb RBu BLu DBr UBl DRf BRd LBd BDI) 3s
 3s 6s 10s.

$[[FB^2, RU], fb^2l^2r]$ (24 moves): (FUl BDI LDf DF1 BUr RFd UFr FDr
 LFu)(FRu DRf RUf ULf DBr UBl RBu)(FLd RDb LUb)(BRd URb DLb)
 9s 7s 3s 3s.

$[[FB, LR], bru^2d^2]$ (24 moves): (FUl UFr UBl FDr BDI DBr DF1 BUr)(FLu
 RFu LBu BLd FRd LFd RBd BRu)(LUb URb RDb)(LUf LDb URf) 8s 8s
 3s 3s.

$[[FB^2, RD'], fb^2u^2d^2]$ (24 moves): (FUl DLb URb)(FUr LUf FLu DFr BRu
 FRd BLd DBI DLf Rdf URf)(FRu BLu RDb LUb)(FLd DF1 BRd DBr) 3s
 11s 4s 4s.

$[[FB^2, RU], lr'ud]$ (24 moves): (FUl URb BRd RFd FLd)(FUr Rdf
 FLu)(FRu RBu BLu RUf BUr DBr LBd RDb UBl BDI)(FDl ULb DFr
 LUf) 5s 3s 10s 4s.

$[[FB^2, L'R], bl^2u^2d']$ (24 moves): (FUl LBd UBl LDf DF1 FLd BRd BDI
 DRf)(FUr DFr FLu BRu RFu LBu)(FRd LUf URf)(LUb URb RDb DLb)
 9s 6s 3s 4s.

$[[FB, RU'], fblr^2]$ (24 moves): (FUl FRu DRf LUb URb RBu FLd)(FUr
 URf FLu LUf DLf LDb FRd BDr)(FDl DRb BUI DBI)(FDr BRd BUr) 7s
 8s 4s 3s.

$[[FB^2, RU'], fb^2lr']$ (24 moves): (FUl DF1 BUr DBr FLd)(FUr DFr BUI
 DBI FLu)(FRu DRf RFd RUf ULf LDf LUb RDb RBu)(BRd URb DLb) 5s
 5s 9s 3s.

$[[FB, LR], br^2u^2d']$ (24 moves): (FUl FDr UBl BDI DBr DF1 UFr BUr)(FLu
 RFu LBu RBd BRu)(FLd RFd LBd)(LUb URb RDb RUf DLb ULf) 8s 5s
 3s 6s.

$[[FB^2, RD'], fb'rd']$ (24 moves): (FUr FRd RBd LBu UBr)(FRu URb LUb
 LBd BDI LDf UBl)(FLd ULf RBu)(FDl DFr BDr LDb DRb Rdf URf) 5s
 7s 3s 7s.

$[[FB^2, RD'], blu^2d]$ (24 moves): (FUl RDb DLb DRf FLd UFr)(FLu DFr

BRu)(FRu BLu RFd BUr LUb DBr)(FDl URf BLd RBd RUb BUl DBl) 6s
3s 6s 7s.

$[[FB^2, RU'], f^2b^2rd^2]$ (24 moves): (FUl DBr BUr Ldf RBu RUf UFr FDr
LFu BDI)(FRu LUb BLu RDb)(FLd BRd URb DLb)(FRd LUf Rdf BLd)
10s 4s 4s 4s.

$[[FB^2, RU'], b^2ru^2d^2]$ (24 moves): (FUl DBr BUr RUf UFr FDr RBu LFu
BDI)(FRu BLu RDb LUb)(FLd BRd URb UBl DLb)(FRd Rdf BLd LUf)
9s 4s 5s 4s.

$[[FB, LR], br^2u^2d^2]$ (24 moves): (FUl FDr BDI BUr)(FUr BUl BDr
FDl)(FLu RFu Lbu BLd FRd Lfd Rbd BRu)(Lub Urb Rdb RUf DLb
ULf) 4s 4s 8s 6s.

$[[FB, L'R], b^2r^2u]$ (24 moves): (FUr BDr BUl DBl FDI DFr UBr)(FLu RFu
BRu Lbu)(FLd RFd BRd LBd)(Lub DRf Ldf Rdb RUf DLb ULf) 7s 4s
4s 7s.

$[[FB, R'U], bl^2u^2d]$ (24 moves): (FUl FRu BUr LUb URb)(FUr URf RBd
FRd Lfd Rdf BLd BDr)(FLu BRu BUl FDI)(BLu BDI RDb DLb ULf) 5s
8s 4s 5s.

$[[FB^2, RU'], b^2ru'd]$ (24 moves): (FUl DBr BUr RBu FRu LFu BDI)(FUr
DFr Lbu URf DRb ULb)(FLd LBd DLb RFd DRf)(BUl RBd RUb LUf) 7s
6s 5s 4s.

$[[FBR^2, U], fbr^2ud]$ (26 moves): (FUl BLu Ldf UBl)(FUr DFr LUf BRu
Rdf FLu)(FRu RUf BUr LUb BRd DBr)(FLd LBd DLb RFd URb RDb)
4s 6s 6s 6s.

$[[FR, U^2D^2], bl^2r'd]$ (24 moves): (FUl RUf DRf RBu BDI)(FUr UBr DFr
BLd BDr ULb Lfd)(FLu RFu BUl FDI LUf)(FRd RUb DRb LDb RBd) 5s
7s 5s 5s.

$[[FB^2, L^2R], b^2l^2r^2u]$ (24 moves): (FUl RUf FLd LBd BDI DRf)(FUr BDr
ULb FRd DRb)(FLu RFu BRu FDI BUl Lbu)(FDr Urb DLb BUr BRd) 6s
5s 6s 5s.

22 edge pieces, 6 cycles

$[[FB, RU], fb^2u^2d^2]$ (24 moves): (FUl DBr)(FUr DBl)(FLu BRu)(FRu DRf
RFd BUr LBd RUf ULf BLu LUb URb DLb RDb)(FLd BRd)(BUl DLf) 2s
2s 2s 12s 2s 2s.

$[[FB, R'U], b^2lu'd^2]$ (24 moves): (FUl DLb LFu BLu DF1 DRf FRu URb
RBu BRd FLd)(FUr FRd BLd)(BUr ULf)(BUl DBl)(BDr URf)(LUb RDb)
11s 3s 2s 2s 2s 2s.

$[[FB', RU], f^2b^2r^2ud]$ (26 moves): (FUl RDb)(FUr LUf BDr RFu DLf LBu
UBr Rdf DFr FLu)(FLd LBd BRd URb)(FRd LDf)(BUl ULb)(BRu URf)
2s 10s 4s 2s 2s 2s.

$[[FB^2, RU'], b^2lr'u^2]$ (24 moves): (FUl DF1 BUr DBr FLd)(FUr DFr BUl
LDb RBd RUb DBl BRu FLu)(FRu BLu)(FRd Rdf)(BLd LUf)(LUb RDb)
5s 9s 2s 2s 2s 2s.

$[[FB, L'R], br^2u^2d']$ (24 moves): (FUl FDr UBl Bdl DBr DF1 UFr
BUr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUb URb RDb RUf
DLb ULf) 8s 2s 2s 2s 2s 6s.

$[[FB, RU], fbud^2]$ (24 moves): (FUl LFu FRu DRf RFd URb RDb)(FUr
DBl)(FLd BRd)(BUr LUb)(BUl DLf)(BRu LBu BDr LDf BLd URf LUf)
7s 2s 2s 2s 2s 7s.

$[[FR, U^2D^2], b^2l^2r^2d]$ (24 moves): (FUl DRf Bdl)(FUr BDr RUb LDf RBd
FRd DRb ULb LFd UBr)(FLu BUl Fdl)(FRu ULf)(FDr LBd)(BRu URf)
3s 10s 3s 2s 2s 2s.

$[[FB, R'U], b^2lu^2d^2]$ (24 moves): (FUl FRu URb DF1 DRf LFu RBu BRd
FLd)(FUr FRd BLd)(BUr ULf)(BUl DBl LDf LBu)(BDr URf)(LUb RDb)
9s 3s 2s 4s 2s 2s.

$[[FB, R'U], b^2lud^2]$ (24 moves): (FUl DF1 DRf BLu DLb RBu BRd
FLd)(FUr FRd BLd)(FLu RFu RUb BUl DBl)(BUr ULf)(BDr URf)(LUb
RDb) 8s 3s 5s 2s 2s 2s.

$[[FB, RU'], b^2l^2r^2u]$ (24 moves): (FUl Bdl)(FUr RUb LFd LDf BDr Fdl
LBu)(FLu URf RFu BRu BUl LUf)(FRd Rdf)(FDr BRd BUr)(LUb RDb)
2s 7s 6s 2s 3s 2s.

$[[FB^2, RU'], b^2l^2u^2d^2]$ (24 moves): (FUl Bdl)(FUr RBd RUb Fdl BDr BUl
LDf LFd)(FLu BRu)(FRu BLu RDb LUb)(FRd Rdf BLd LUf)(BUr RUf)
2s 8s 2s 4s 4s 2s.

$[[FB^2, RD], fb^2u^2d^2]$ (24 moves): (FUl DLb RDb LUb URb)(FUr LUf FLu
DBl BRu Rdf URf)(FRu BLu)(FLd DBr BRd DF1)(FRd BLd)(FDr LDf)
5s 7s 2s 4s 2s 2s.

$[[FB, L'R], br^2ud']$ (24 moves): (FUl DF1 FDr UBl Bdl DBr)(FUr

U_{Br}(F_{Lu} R_{Fu} B_{Ru} L_{Bu})(F_{Ld} B_{Rd})(F_{Rd} B_{Ld})(L_{Ub} U_{Rb} R_{D_b} R_{Uf} D_{Lb} U_{Lf}) 6s 2s 4s 2s 2s 6s.

[[$FB^2, R'D'$], $fb^2r'u$] (24 moves): (F_{U_l} B_{Rd} B_{D_l} L_{Df} U_{Lf})(F_{U_r} D_{F_r})(F_{L_u} U_{Rf} B_{Ru} D_{Rb} U_{Lb} L_{Bu})(F_{Ru} U_{B_l} D_{Rf} L_{Bd} D_{F_l})(B_{U_r} D_{B_r})(L_{D_b} R_{U_b}) 5s 2s 6s 5s 2s 2s.

[[FB^2, RU'], fb^2lr] (24 moves): (F_{U_l} D_{B_r} F_{Ld})(F_{U_r} U_{B_r})(F_{L_u} F_{D_l} D_{F_r})(F_{Ru} D_{Rf} R_{Fd} R_{Uf} U_{Lf} L_{Df} L_{Ub} R_{D_b} R_{Bu})(B_{U_l} D_{B_l})(B_{Rd} U_{Rb} D_{Lb}) 3s 2s 3s 9s 2s 3s.

[[$FB, L'R$], $br'u^2d^2$] (24 moves): (F_{U_l} D_{B_r} D_{F_l} F_{D_r} B_{D_l} U_{F_r} U_{B_l} B_{U_r})(F_{L_u} B_{Ru})(F_{Ru} B_{Lu})(F_{Ld} L_{Bd} B_{Rd} R_{Fd})(L_{Ub} U_{Rb} R_{D_b})(L_{Uf} L_{D_b} U_{Rf}) 8s 2s 2s 4s 3s 3s.

[[$FB^2, L'R$], b^2l^2ud'] (24 moves): (F_{U_l} U_{B_l} L_{Df} D_{F_l} L_{Bd} B_{D_l} D_{Rf})(F_{U_r} D_{F_r} L_{Bu})(F_{L_u} R_{Fu} B_{Ru})(F_{Ld} U_{Lf} R_{Fd} R_{Uf} B_{Rd})(L_{Ub} R_{D_b})(L_{D_b} R_{U_b}) 7s 3s 3s 5s 2s 2s.

[[FB, LR], b^2r^2ud'] (24 moves): (F_{U_l} D_{F_l} F_{D_r} U_{B_l} B_{D_l} D_{B_r})(F_{U_r} U_{B_r})(F_{L_u} R_{Bd})(F_{Ru} R_{Bu} B_{Lu} L_{Bd} F_{Ld} R_{Fd})(L_{Ub} R_{D_b} R_{Uf})(L_{Uf} R_{Ub} L_{D_b}) 6s 2s 2s 6s 3s 3s.

[[$FB^2, L'R$], $blr'u^2$] (24 moves): (F_{U_l} B_{Rd} U_{B_l} D_{Rf} L_{Df} D_{F_l} L_{Bd})(F_{U_r} U_{B_r} L_{D_b} D_{F_r})(F_{L_u} B_{Ru})(F_{Ru} B_{Lu})(F_{Ld} R_{Fd} U_{Lf} R_{Uf})(L_{Ub} U_{Rb} R_{D_b}) 7s 4s 2s 2s 4s 3s.

[[$FB, L'R$], b^2ru^2d'] (24 moves): (F_{U_l} U_{F_r} D_{B_r} D_{F_l} B_{U_r})(F_{L_u} B_{Ru})(F_{Ru} B_{Lu})(F_{Ld} L_{Bd} B_{Rd} R_{Fd})(F_{D_r} U_{B_l} B_{D_l})(L_{Ub} R_{D_b} U_{Lf} R_{Uf} U_{Rb} D_{Lb}) 5s 2s 2s 4s 3s 6s.

[[FR, U^2D^2], bl^2r^2d] (24 moves): (F_{U_l} R_{Uf} D_{Rf} R_{Bu} B_{D_l})(F_{U_r} B_{D_r} U_{Lb} L_{Fd} U_{B_r})(F_{L_u} B_{U_l} F_{D_l})(F_{Ru} U_{Lf})(F_{Rd} R_{Ub} D_{Rb} L_{D_b} R_{Bd})(F_{D_r} L_{Bd}) 5s 5s 3s 2s 5s 2s.

[[FB, LR], $lrud^2$] (24 moves): (F_{U_r} D_{B_l} B_{D_r} B_{U_l} D_{F_r} F_{D_l})(F_{L_u} R_{Fu} B_{Ru} L_{Bu})(F_{Ld} B_{Rd})(F_{Rd} B_{Ld})(L_{Ub} U_{Rb} L_{Df} D_{Rf})(L_{Uf} D_{Rb} L_{D_b} U_{Rf}) 6s 4s 2s 2s 4s 4s.

[[FB, RU], fb^2r^2] (24 moves): (F_{U_l} B_{D_l})(F_{U_r} B_{D_r})(F_{L_u} L_{Uf} R_{Fu} R_{Df} U_{Rf})(F_{Ld} R_{D_b} D_{Lb} R_{Fd} U_{Rb})(F_{D_l} B_{Ru} B_{U_l} D_{Lf})(F_{D_r} B_{Rd} B_{U_r} L_{Ub}) 2s 2s 5s 5s 4s 4s.

[[FB^2R', U^2], $f^2b^2ru'd^2$] (26 moves): (F_{U_l} B_{Lu} U_{Rb} U_{Lf} B_{U_r} U_{F_r} F_{D_r} U_{B_l})(F_{L_u} B_{D_r})(F_{Ld} B_{Rd} B_{D_l})(F_{Rd} D_{Rb} D_{Lf})(B_{Ru} R_{Df} L_{D_b})(B_{Ld} U_{Rf}

ULb) 8s 2s 3s 3s 3s 3s.

[[$FB, R'U$], b^2l^2rd'] (24 moves): (FUl BDI)(FUr UBr LUf)(FLu BLd URf DFr)(FRu URb DLb)(FLd DRf RFd BRd LUb RDb DBr)(FDl BRu BUl) 2s 3s 4s 3s 7s 3s.

[[$FB, R'U$], $b^2l^2r^2d^2$] (24 moves): (FUl BDI)(FUr FRd BLd BDr URf)(FLu ULb DRb)(FRu URb DLb)(FLd DRf BRd BUr ULf FDr)(FDl BRu BUl) 2s 5s 3s 3s 6s 3s.

[[FB, LR], $br'u'd'$] (24 moves): (FUl UFr BUr DF1)(FLu BRu RFu)(FLd RFd LBd)(FDr UBl BDI DBr)(BLu BRd)(LUb URb RDb RUf DLb ULf) 4s 3s 3s 4s 2s 6s.

[[$FB, R'U$], $bl^2u^2d^2$] (24 moves): (FUl FRu BUr LUb URb)(FUr FRd BLd)(FLu BRu BUl FDI)(FLd DRf BRd)(BLu BDI RDb DLb ULf)(BDr URf) 5s 3s 4s 3s 5s 2s.

[[FB^2, RU'], $b^2r^2u^2d^2$] (24 moves): (FUl RBu LFu)(FUr BDr)(FRu BLu RDb LUb)(FLd BRd URb UBl DLb)(FRd Rdf BLd LUf)(FDr BDI BUr RUf) 3s 2s 4s 5s 4s 4s.

[[FB, LR], $lrud'$] (24 moves): (FUr BDr BUl FDI)(FLu RFu BRu LBU)(FLd RFd BRd LBd)(FDr BDI)(LUb URb Ldf DRf)(LUf DRb LDb URf) 4s 4s 4s 2s 4s 4s.

[[FR, D^2], $fb^2l^2r^2u^2d'$] (24 moves): (FUl BUr BLu)(FUr BUl RBd ULb FLu Rdf LDb)(FRu FDr BDI)(FRd FDI BDr)(BRu DRb DLf)(BLd RUb URf) 3s 7s 3s 3s 3s 3s.

[[FB^2R', U^2], $f^2b^2rud^2$] (26 moves): (FUl FRu BUr UFr FDr UBl)(FLu BDr Rdf LDb)(FLd BRd BDI)(FRd DRb DLf)(BLu URb ULf)(BLd URf ULb) 6s 4s 3s 3s 3s 3s.

[[FB, R], $b^2lru^2d^2$] (22 moves): (FUl FRu BLu UBl DRf)(FUr FRd DRb)(FLu UBr URf BDr BRu)(FLd DF1 DLb)(FDr LUb LBd)(BRd URb BDI) 5s 3s 5s 3s 3s 3s.

[[$FB, L'R$], $br'ud^2$] (24 moves): (FUl DF1 DBr)(FUr BUl UBr DFr DBI)(FLu RFu BRu LBU)(FLd LBd BRd RFd)(LUb URb RDb)(LUf LDb URf) 3s 5s 4s 4s 3s 3s.

[[FB, LR], $lr'ud'$] (24 moves): (FLu RFu BRu LBU)(FLd RFd BRd LBd)(FDl BDr BUl)(FDr BDI BUr)(LUb URb Ldf DRf)(LUf URf LDb DRb) 4s 4s 3s 3s 4s 4s.

22 edge pieces, 8 cycles

[[$R'B^2L, U^2D^2$], f^2l^2d'] (26 moves): (FUl BDI)(FUr BDr)(FLu RFu LFd FRd RBd BLd LUf RDf)(FDl BUl)(FDr BUr)(BRu ULb)(LDb RUb)(LDf RUf) 2s 2s 8s 2s 2s 2s 2s 2s.

[[$FR'B, U^2$], $fb^2l^2r^2d$] (26 moves): (FUl BUr)(FUr BUl)(FLu LUf RBd RUb BRu BLd URf)(FLd DRf)(FRd DLf LDl)(FDl BDr)(FDr BDI)(LUb RDb) 2s 2s 7s 2s 3s 2s 2s 2s.

[[FB, RU], $fb'u^2d^2$] (24 moves): (FUl DBr)(FUr DBl)(FLu BRu)(FRu DRf RFd RDb)(FLd BRd)(BUr DLb)(BUl DLf)(BLu URb LUb LBd RUf ULf) 2s 2s 2s 4s 2s 2s 2s 6s.

[[FB, RU], fbu^2d^2] (24 moves): (FUl DBr)(FUr DBl)(FLu BRu)(FRu DRf RFd URb RDb)(FLd BRd)(BUr LUb)(BUl DLf)(BLu DLb LBd RUf ULf) 2s 2s 2s 5s 2s 2s 2s 5s.

[[$FB, L'R$], $blru^2d'$] (26 moves): (FUl UFr DBr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(FDl UBr BUl)(FDr BDI)(LUb DRf LDf RDb ULf RUf) 3s 2s 2s 2s 2s 3s 2s 6s.

[[FB^2, RU'], b^2lru^2] (24 moves): (FUl DBr FLd)(FUr UBr)(FLu FDI DFr BRu)(FRu BLu)(FRd RDf)(BUl LDl RBd RUb DBl)(BLd LUf)(LUb RDb) 3s 2s 4s 2s 2s 5s 2s 2s.

[[$FR'B, U^2$], $f^2b^2l^2r^2d$] (26 moves): (FUl BUr)(FUr BUl)(FLu DLf BRu URf)(FLd DLb RFd DRf)(FDl BDr)(FDr BDI)(BRd URb LBd ULf)(LUb RDb) 2s 2s 4s 4s 2s 2s 4s 2s.

[[FR^2, D^2F^2], $fblr'd^2$] (26 moves): (FUl BDI DFl)(FUr BDr FRd BUl LFd)(FRu BUr RBu)(FDr BRd LBd)(LUb RUf)(LUf RDf)(LDl RUb)(LDf RDb) 3s 5s 3s 3s 2s 2s 2s 2s.

[[FR^2, U^2D^2], $bl^2r^2d^2$] (24 moves): (FUl FRu BDI)(FUr BLd)(FLu BUl FDI)(FLd BUr)(FRd BDr)(FDr BRd)(LUb URb RDb DLb)(LUf URf RDf DLf) 3s 2s 3s 2s 2s 2s 4s 4s.

[[$FB, R'U$], $b^2l^2u^2d^2$] (24 moves): (FUl FRu URb)(FUr FRd BLd)(FLu BRu BUl FDI)(FLd DRf BRd)(BUr ULf)(BLu BDI DLb)(BDr URf)(LUb RDb) 3s 3s 4s 3s 2s 3s 2s 2s.

[[FR, D^2], $fb^2l^2r^2u^2d^2$] (24 moves): (FUl BUr BLu)(FUr BUl BLd)(FLu RDf)(FRu FDr BDI)(FLd LUb RUf)(FRd FDI BDr)(BRu DRb DLf)(BRd DLb) 3s 3s 2s 3s 3s 3s 3s 2s.

22 edge pieces, 10 cycles

$[[RBL', U'D^2], b^2l^2d^2]$ (26 moves): (FUl UBl DFl BDI)(FLu DLf)(FRu BLu)(FLd BRd)(FRd BLd)(BUr RUf)(BRu RDf)(BDr LUF)(LUB RDb)(LDb RUB) 4s 2s 2s 2s 2s 2s 2s 2s 2s 2s.

$[[FR^2, U^2D^2], b^2l^2r^2d^2]$ (24 moves): (FUl FRu BDI)(FUr BLd)(FLu BUl FDI)(FLd BUr)(FRd BDr)(FDr BRd)(LUB RDb)(LUf RDf)(LDb RUB)(LDf RUf) 3s 2s 3s 2s 2s 2s 2s 2s 2s 2s.

23 edge pieces, 1 cycle

$[[FB, RU], fblr^2d]$ (26 moves): (FUl UBl LDf BDI BRd BUr LUb FDr RFd URb RBU LBd DBr UFr RUf LFu ULf FRu DRf DFl RDb DLb FLd) 23s.

23 edge pieces, 3 cycles

$[[FB, RU], fbr^2u'd]$ (26 moves): (FUl DLb FLd LBd DBr RBU FRu DRf BDI BRd BUr LUb FDr RFd URb RDb UFr RUf BLu)(FLu LUf)(BUl DLf) 19s 2s 2s.

$[[FB, RU], fbrud']$ (26 moves): (FUl LFu LBd BDI RUf DBr DLb BRd ULf RBU BLu BUr LUb UFr FLd RFd URb RDb)(FRu DRf FDr)(BUl DLf) 18s 3s 2s.

$[[FB, RU], fbrud^2]$ (26 moves): (FUl LFu FLd BRd ULf RBU BLu BUr LUb UFr BDI FDr FRu DRf RFd URb RDb)(BUl DLf)(BLd URf BDr LDb) 17s 2s 4s.

$[[FB, RU], fbrud]$ (26 moves): (FUl LFu RFd URb RDb)(FUr URf BDr LDb LFd BLd DFr RFu RDf DBl RBd LUf BRu LBU UBr ULb)(BUl DLf) 5s 16s 2s.

$[[FB, RU], fbru^2d]$ (26 moves): (FUl BUr LUb UFr RUf DBr)(FLu FRd RUB DRb RFu RDf DBl RBd LUf LBU LDb LFd BLd DFr BRu)(BUl DLf) 6s 15s 2s.

$[[FB, RU], fbru'd']$ (26 moves): (FUl DLb BRd ULf LFu LBd BDI RUf DBr RBU FRu DRf FDr BLu)(FUr LFd FRd RUB DRb UBr ULb)(BUl DLf) 14s 7s 2s.

$[[FB, RU], fbr'u'd]$ (26 moves): (FUl DLb FLd LBd BUr LUb DBr RBU FRu DRf BDI BRd BLu)(FUr URf FRd RUB DRb DFr LUf FLu)(BUl DLf) 13s 8s 2s.

$[[FB, RU], fbr^2u^2d']$ (26 moves): (FUl UFr FLd RFd URb RDb FRu DRf DBr)(FLu LUf LBu LDb RBd UBr ULb DFr BLd DBl URf BRu)(BUl DLf) 9s 12s 2s.

$[[FR, U^2D^2], brud^2]$ (24 moves): (FUl RUf DRf BLu LDf BDI UBl LFu ULf DFl RBu)(FUr DFr BDr FRd BLd UBr ULb RUb DRb LDb)(FLd BRd) 11s 10s 2s.

$[[FB, RU'], b^2lr'u^2d]$ (26 moves): (FUl UBl FRu BLu BDI BRd RBu LBd RDb LUb DBr ULf FDr RUf RFd DRf FLd)(FUr RUb FLu)(FDl LDl UBr) 17s 3s 3s.

$[[FB, RU], fbl^2r^2d]$ (26 moves): (FUl BDI BRd BUr LUb FDr RFd URb LBd DBr UFr RUf LFu ULf FRu DRf)(FLd RDb DLb)(FDl BRu BUl DLf) 16s 3s 4s.

$[[FB, RU], fb'l'rd]$ (26 moves): (FUl DFl LBd FDr LFu RFd RDb URb BDI BRd ULf FRu DRf UBl LDf)(FUr URf BDr UBr LDl)(FLd RBu LUb) 15s 5s 3s.

$[[FB, RU], fb^2l'ru']$ (26 moves): (FUl LUb URb BDI UBl LDf)(FUr DFr LBu FDI LFd RFu RDf URf BDr BRu LDl DRb UBr FRd)(FLu RBd LUf) 6s 14s 3s.

$[[FB', RU'], bl^2r^2u]$ (24 moves): (FUl BDI FLd)(FUr FDI BLd BUl URf LUf BDr RFu BRu LBu UBr DFr FLu)(FRd RBd RDf ULb RUb DRb LDl) 3s 13s 7s.

$[[FBR', U'], f^2b^2r^2ud]$ (26 moves): (FUl LUb FLd DLb UBl URb LBd RDb)(FUr LUf FLu RFu RDf BDr RBd UBr URf DLf DFr FRd)(BRu LBu DBl) 8s 12s 3s.

$[[FR, U^2D^2], brud']$ (24 moves): (FUl RUf DRf BLu LDf BDI UBl LFu ULf DFl RBu)(FUr DFr BDr)(FLd RFd BRd LBd LUb URb RDb DLb BUr) 11s 3s 9s.

$[[FBR^2, U], bl^2r^2ud]$ (26 moves): (FUl BDI LBd DLb RFd URb UBl DFl RDb FLd)(FUr DFr URf UBr ULb RBd BDr RFu RDf FLu)(BRu LBu LUf) 10s 10s 3s.

$[[FB, RU], fbl^2r^2d^2]$ (26 moves): (FUl BDI DBr UFr)(FLu LUf RFu RDf FRd RUb RBd UBr ULb DFr LFd DRb LDl BLd URf)(FDl BRu BUl DLf) 4s 15s 4s.

$[[FB, RU], fblr'u]$ (26 moves): (FUl LFu UFr BUr LUb DBr DLb RFd URb

BLu FDr ULf RBu FLd)(FRu DRf RUf BRd)(FDl DRb BUl DLf DBl) 14s
4s 5s.

[[FB, RU], $fb^2r^2u^2$] (26 moves): (FUl UFr DBr UBl LDf BDI DF1 RDb FRu
DRf RUf RBu FLd)(FLu LUf LBu LDb FRd RUB)(FDr BRd BUr LUb)
13s 6s 4s.

[[FRB', D'], $b^2l^2r^2u^2d^2$] (26 moves): (FUl LUb BUr BLu LFu DLb URb
RBu FRu FDr RDb BDI)(FUr RDf BDr DLf)(FLd RUf BRd RFd DF1 UBl
LBd) 12s 4s 7s.

[[FB, RU], $fb^2l'r'u$] (26 moves): (FUl LFu UFr BUr RFd DBr LUb URb
BDI UBl LDf)(FRu DRf RUf BRd)(FLd BLu FDr ULf RBu DLb RDb
DF1) 11s 4s 8s.

[[FB, RU], $fb^2l'rd^2$] (26 moves): (FUl DF1 BRd ULf FRu DRf RFd UFr
UBl LDf)(FLu LFd BRu LDb DRb ULb RUB DBI DFr)(BUr LBd RUf
DBr) 10s 9s 4s.

[[FB, RU'], $fb^2lu'd$] (26 moves): (FUl LFu BLu LDf LUb BUr DF1 DLb
UFR URb FRu DRf FLd)(FRd URf LUf DBI RBd)(BUl BDr BRu BLd
DRb) 13s 5s 5s.

[[FBR', U], f^2b^2rud] (26 moves): (FUl RUf RFd RDb UFr URb DLb FDr
FRu BDI LFu LDf)(FLd LBd BUr LUb BRd DBr)(BUl LUf BRu LBu
RDf) 12s 6s 5s.

[[FB^2R, D], $f^2b^2r^2ud$] (26 moves): (FUr BUl BDr RDf LUf)(FLu LFd RUB
FDI LDb FRd LBu)(FRu LBd LUb BDI RDb BRd RBu RUf BUr FDr
LDf) 5s 7s 11s.

[[FB, RU^2], $f^2b^2r^2ud^2$] (26 moves): (FUl BLu UFr RFd RDb LUb LBd
DBr)(FLu URf BUl DLf RFu RDf UBr DFr LUf BRu)(FLd URb DLb BRd
BDI) 8s 10s 5s.

[[FB^2R, D'], f^2b^2rud] (26 moves): (FUr URf DBI DLf LUf FDI RDf BRu
RBd)(FLu BUl LBu FRd LFd)(FRu FDr RDb LUb DBr DLb URb BUr
LBd) 9s 5s 9s.

[[FB, L^2R], fb^2lrd^2] (26 moves): (FUl UBl DLb FLd BRd URb)(FUr FLu
DFr LUf BRu RFu RDf DBI LBu FDI URf)(FRd DRb BDr UBr ULb BLd)
6s 11s 6s.

[[FB, RU], $fb^2l'r'd^2$] (26 moves): (FUl DF1 BRd LFu UFr UBl LDf)(FRu
DRf RFd URb BDI BUr LUb DBr FDr ULf)(FLd RBu RDb DLb LBd

RUf) 7s 10s 6s.

$[[FB, RU], fb^2lr'd^2]$ (26 moves): (FUl UBl LDf BDI BUr LBd RUf FLd)(FUr FDI LDf DRb ULb RUb BRu RBd FLu)(FRu DRf RFd DBr FDr ULf) 8s 9s 6s.

$[[FB, RU], fblrd^2]$ (26 moves): (FUl UBl LDf BDI FDr LFu FLd)(FUr FDI DRb LDf BLd URf BDr UBr ULb)(FRu DRf RFd URb RBu BRd ULf) 7s 9s 7s.

$[[FB^2R, D], f^2b^2rud]$ (26 moves): (FUr RBd BRu URf BDr RDf LUf UBr)(FLu LFd RUb FDI LDf FRd LBu)(FRu LBd UBl LUb BDI RDf FDr LDf) 8s 7s 8s.

23 edge pieces, 5 cycles

$[[FB^2, RU], blr'ud^2]$ (26 moves): (FUl RDb UBl BDI FRu RBu BLu BUr LUb FDr ULf DFf URb RFd FLd)(FUr FLu)(BRd DBr)(BLd LDf)(RUf DRf) 15s 2s 2s 2s 2s.

$[[FB^2, RU], bl^2r'ud^2]$ (26 moves): (FUl RDb BDI FRu RBu BLu BUr LUb BRd DBr UBl DFf FDr ULf)(FUr FLu)(FLd URb RFd)(BLd LDf)(RUf DRf) 14s 2s 3s 2s 2s.

$[[FB, RU], fb^2r^2u'd']$ (26 moves): (FUl LUb URb DLb RDb UFr FLd RFd FDr LBd BDI RUf BLu)(FLu LUf)(FRu DRf DBr RBu)(BUr BRd)(BUl DLf) 13s 2s 4s 2s 2s.

$[[FB^2, RD'], blru'd']$ (26 moves): (FUl DBr RBu FRu DLb DRf BRd URb BLu LBd FLd RUf)(FUr FRd)(FLu BUl)(FDf DFr DRb DLf DBl)(BUr LUb) 12s 2s 2s 5s 2s.

$[[FB^2, RU], blru'd^2]$ (26 moves): (FUl DLb LBd RDb RFd FLd)(FUr BRu RFu FLu FDI RUb BUl DBl LUf BDr RBd)(FDr BLu)(BUr LUb)(RUf DRf) 6s 11s 2s 2s 2s.

$[[FB^2, RU], f^2b^2r^2ud]$ (26 moves): (FUl DLb RFd FDr BDI BUr FLd LBd LUb RDb)(FUr LUf RFu BUl BRu URf BDr)(FLu RDf)(BLu LDf)(BRd URb) 10s 7s 2s 2s 2s.

$[[FR, U^2D^2], b^2rud^2]$ (24 moves): (FUl DRf)(FUr DFr BDr FRd BLd UBr RUb LDf)(FLu LUf FDI BRu URf LBu DLf DBl BUl)(FLd BRd)(LUb RDb) 2s 8s 9s 2s 2s.

$[[FB', RU'], b^2l^2r^2u]$ (24 moves): (FUl BDI FLd)(FUr FDI BLd BUl URf

$LUf BDr RFu BRu LBU UBr DFr FLu)(FRd RdF)(BRd URb DLb)(LUB$
 $RDb) 3s 13s 2s 3s 2s.$

$[[FB, RU], fb^2l^2r'd] (26 \text{ moves}): (FUl BDI)(FUr LUf BDr UBr DLf FDI$
 $BRu BUl LFd URf RBd FLu)(FRu URb DLb)(FRd DRb)(FDr LUb DRf$
 $LBd) 2s 12s 3s 2s 4s.$

$[[FB, RU], fb^2l^2rd] (26 \text{ moves}): (FUl BDI)(FUr LUf)(FLu FRd DRb BDr$
 $DFr)(FRu URb DLb)(FLd RUf BRd LUb DRf LBd BUr LDf DFf RBu$
 $UBl) 2s 2s 5s 3s 11s.$

$[[FB, RU], fb^2l^2r'd^2] (26 \text{ moves}): (FUl BDI)(FUr FRd DRb LFd URf DFr$
 $ULb RdF RBd FLu)(FRu URb DLb)(FDl BRu BUl BLd UBr DLf)(BDr$
 $LUf) 2s 10s 3s 6s 2s.$

$[[FR, U^2D^2], b^2rud'] (24 \text{ moves}): (FUl DRf)(FUr DFr BDr)(FLu LUf FDI$
 $BRu URf LBU DLf DBl BUl)(FLd RFd BRd LBd URb DLb BUr)(LUB$
 $RDb) 2s 3s 9s 7s 2s.$

$[[FB, LR], b^2lr^2ud^2] (26 \text{ moves}): (FUr DBl UBr)(FLu BLd FRd RFu BRu$
 $LBU LFd RBd)(FDl DFr)(BUl BDr)(LUB DLb ULf URb LDf DRf RDb$
 $RUf) 3s 8s 2s 2s 8s.$

$[[FB, RU], fb'r^2u'd'] (26 \text{ moves}): (FUl URb LUb BRd BUr DLb FDr LBd$
 $BDl RUf BLu)(FUr LFd FRd DRb)(FLu LUf)(FRu DRf DBr RBu)(BUl$
 $DLf) 11s 4s 2s 4s 2s.$

$[[FB, RU], fbr^2u'd'] (26 \text{ moves}): (FUl DLb BRd BUr LUb FDr LBd BDl$
 $RUf BLu)(FUr LFd FRd RUB DRb)(FLu LUf)(FRu DRf DBr RBu)(BUl$
 $DLf) 10s 5s 2s 4s 2s.$

$[[FB, RU'], bl'r^2ud^2] (26 \text{ moves}): (FUl DFf BRd FRu RBu RDb DLb LBd$
 $DBr)(FUr RdF ULb BUl LUf FLu)(FLd BLu FDr RUf)(FRd UBr)(BDl$
 $URb) 9s 6s 4s 2s 2s.$

$[[FB, LR], blr^2u^2] (24 \text{ moves}): (FUl FDr BUr UBl BDl DFf UFr DBr)(FLu$
 $BRu)(FRu BLu)(FLd RFd BRd LBd)(LUB DRf LDf RDb RUf DLb ULf)$
 $8s 2s 2s 4s 7s.$

$[[FB, RU], fbr^2u'd^2] (26 \text{ moves}): (FUl DLb LBd RUf BLu)(FUr DBl BDr$
 $BRu RFu RdF FRd RUB DRb)(FLu LUf)(FLd BRd BUr LUb FDr)(BUl$
 $DLf) 5s 9s 2s 5s 2s.$

$[[FB, LR], b^2lr^2ud'] (26 \text{ moves}): (FUr UBr)(FLu RBd)(FRu RBu BLu LBd$
 $FLd RFd)(FDl DFr DBl BDr BUl)(LUB DLb ULf URb LDf DRf RDb$

RUf) 2s 2s 6s 5s 8s.

$[[FB^2, RU], b^2lr'u'd']$ (26 moves): (FUl LUb FDr ULf DFf RDf FLd)(FUr URf BRu RFu FLu)(FRd BDr)(BUr BRd URb UBl BBl BLu DRf)(BLd DLb) 7s 5s 2s 7s 2s.

$[[FB, R'U'], fb^2l^2r'u'd']$ (26 moves): (FUl BBl FRu RDf FDr DLb)(FUr DFf BRu BUl RBd FLu)(FLd RUf)(BUr DDr DRf LBd URb LUb)(LUf DLf) 7s 6s 2s 6s 2s.

$[[FB, R'U'], fb^2l^2u^2d']$ (26 moves): (FUl FRu URb)(FUr DFf FLu BRu BUl RBd FRd BDr RDf BLd DRb ULb)(FLd RUf)(BUr DLf ULf)(BLu BBl DLb) 3s 12s 2s 3s 3s.

$[[FB, R'U'], fb^2l^2r^2u^2d']$ (26 moves): (FUl FRu URb)(FUr BDr)(FLu ULb RDf LFd URf LUf DDr RBd UBr DLf DFf)(FRd DRb BRu BUl)(BLu BBl DLb) 3s 2s 11s 4s 3s.

$[[FB, RU], fb^2rud']$ (26 moves): (FUl LFu LBd BBl RUf DDr LUb URb DLb RDf)(FUr LFd FRd)(FRu DRf FDr)(BUr BRd ULf RBu BLu)(BUl DLf) 10s 3s 3s 5s 2s.

$[[FB^2, RD], fb^2lr^2u']$ (26 moves): (FUl DFf BRd)(FUr BDr)(FLu BUl ULb RUb LBu URf LUf RFu BLd)(FRd DDr DLf UBr BRu RDf)(BBl DLb RDf) 3s 2s 9s 6s 3s.

$[[FB, R'U'], bl^2rud']$ (26 moves): (FUl BBl BRd RUf DDr DFf BLu BUr)(FUr RDf ULb)(FLu FRd DDr RFu BRu BUl LUf)(FLd RDf DLb)(BLd RUB) 8s 3s 7s 3s 2s.

$[[FB, RU], fb^2r'u'd']$ (26 moves): (FUl LFu UFr RUf RFd DDr LUb URb DLb RDf)(FRu DRf BBl BRd)(FLd LBd BUr)(FDr ULf RBu BLu)(BUl DLf) 10s 4s 3s 4s 2s.

$[[FB, R'U'], fb^2lr'u'd']$ (26 moves): (FUl FRu DRf FLd)(FUr RUB BRu BLd DRb BUl BBl RBd FLu)(FRd URf)(DFf DLb UBr)(FDr ULf DLf LUb DDr) 4s 9s 2s 3s 5s.

$[[FB, RU], fbr'u'd']$ (26 moves): (FUl DLb BRd BLu)(FUr LFd FRd RUB DRb DDr LUf FLu)(FRu DRf BUr LUb DDr RBu)(BUl DLf)(BLd BBl URf) 4s 8s 6s 2s 3s.

$[[FB, RU], fbr'u'd']$ (26 moves): (FUl LFu UFr FLd RFd URb RDf)(FRu DRf BUr LUb DDr DLb BRd)(FDr ULf RBu BLu)(BUl DLf)(BLd BBl URf) 7s 7s 4s 2s 3s.

$[[FB, RU'], fb^2l^2ud^2]$ (26 moves): (FUl RBu UBl LDf LUb)(FUr RUb RBd LFd LDf)(FLu RFu RDf BLd UBr FRd URf LUf)(FDl LBu BDr)(BDl RDb) 5s 5s 8s 3s 2s.

$[[FB, RU], fb'r'u'd']$ (26 moves): (FUl URb LUb BRd BLu)(FUr LFd FRd DRb DFr LUf FLu)(FRu DRf BUr DLb DBr RBu)(BUl DLf)(BLd DBl URf) 5s 7s 6s 2s 3s.

$[[FB^2, R'U'], fb^2l^2u^2d^2]$ (26 moves): (FUl RUf LBd BRd DRf BDI)(FUr ULb FDI BDr BUl DRb)(FLu BRu LDf LBu RFu RUb)(FLd RFd)(BUr LDf ULf) 6s 6s 6s 2s 3s.

$[[FB^2, RU], bl'r'u'd^2]$ (26 moves): (FUl DLb LBd RDb RFd FLd FDr ULf UBl)(FUr BRu RFu FLu)(FDl RBd BDr RUb)(BUr LUb BDI BLu)(RUf DRf) 9s 4s 4s 4s 2s.

$[[FB, L'R], b^2lr^2ud']$ (26 moves): (FUr UBr)(FLu RFu BRu LBu)(FLd LBd BRd RFd)(FDl DFr DBl BDr BUl)(LUb DRf LDf DLb ULf URb RDb RUf) 2s 4s 4s 5s 8s.

$[[FB, RU], fbr'ud]$ (26 moves): (FUl LFu UFr RUf RFd URb RDb)(FRu DRf BDI BRd)(FLd LBd BUr LUb DBr DLb)(FDr ULf RBu BLu)(BUl DLf) 7s 4s 6s 4s 2s.

$[[FB, RU], fbr^2u^2d^2]$ (26 moves): (FUl UFr BDI DBr)(FLu LUf LBu LDf BLd URf BRu)(FRu DRf RFd URb RDb)(FLd BRd BUr LUb FDr)(BUl DLf) 4s 7s 5s 5s 2s.

$[[FB, RU], fb^2l'r^2u']$ (26 moves): (FUl LUb URb BDI UBl LDf)(FUr BDr BRu LDf DRb)(FLu LUf)(FRu DRf RUf BLu DF1 FLd)(FRd DFr RBd UBr) 6s 5s 2s 6s 4s.

$[[FB, R'U], bl'r^2ud^2]$ (26 moves): (FUl UBl)(FUr FRd BLd BDr URf)(FLu LDf LUf BRu RDf DBl)(FRu FDr FLd BLu RDb)(FDl RBd UBr ULb RUb) 2s 5s 6s 5s 5s.

$[[FB, R'U'], fb^2l^2u^2d']$ (26 moves): (FUl FRu URb)(FUr DRb ULb LFd URf RBd BLd FDI FLu BRu BUl)(FRd BDr RDf)(BUr LDf ULf)(BLu BDI DLb) 3s 11s 3s 3s 3s.

$[[FB, RU'], fb^2l'r^2u']$ (26 moves): (FUl LFu ULf)(FUr RUb DBl BUl)(FRu DRf RFd RUf BLu LDf LUb RDb DF1 FLd)(FDr BRd BUr)(BRu LDf BDr) 3s 4s 10s 3s 3s.

$[[FB', RU'], fb^2lr^2]$ (24 moves): (FUl UBl BDI LBd FLd)(FUr BDr

FLu)(FRu DRf RFd RUf ULf LDf LUb RDb RBu)(FDr BLu BUr)(BRd URb DLb) 5s 3s 9s 3s 3s.

[[FB, RU'], $fb'lru$] (26 moves): (FUl RBu FLd)(FUr FRd DRb BUl DLf RUB LBu UBr)(FLu RBd LUf)(FRu DRf FDr)(FDl ULb LDl URf BDr DBl) 3s 8s 3s 3s 6s.

[[$FB, R'U$], $b^2l^2ru^2d'$] (26 moves): (FUl FRu URb)(FUr UBr LUf)(FLu BLd URf DFr BRu BUl FDI)(FLd DRf RFd BRd LUb RDb DBr)(BLu BDI DLb) 3s 3s 7s 7s 3s.

[[FB, RU'], fb^2lru] (26 moves): (FUl RBu FLd)(FUr RUB LBu UBr)(FLu RBd LUf)(FRu DRf RFd RUf DBr BDI DF1 DLb FDr)(BUl DLf ULb DRb) 3s 4s 3s 9s 4s.

[[$FB, R'U$], $bl'r^2u'd^2$] (26 moves): (FUl RDb BLu UBl)(FUr FRd BLd BDr URf)(FLu LDl LUf)(FRu FDr FLd)(FDl RBd UBr ULb RUB BRu Rdf DBl) 4s 5s 3s 3s 8s.

[[FB, RU'], $fb'l'rd'$] (26 moves): (FUl FRu DRf FDr LFu LBd UBl)(FUr RBd LUf DLf RUB DBl)(FLd RBu LUb)(FRd DRb FDI)(BUr DLb RUf DBr) 7s 6s 3s 3s 4s.

[[$FB, R'U$], $fb^2l^2r'u^2$] (26 moves): (FUl FRu URb)(FUr UBr DLf FDI FLu)(FLd RUf ULf DBr FDr LUb DRf)(FRd DRb RBd BRu BUl)(BLu BDI DLb) 3s 5s 7s 5s 3s.

[[FB', RU'], $fblr^2$] (24 moves): (FUl UBl BDI LBd FLd)(FUr BDr FLu)(FRu DRf LUb URb RDb RBu)(FRd RBd URf LUf DLf LDl)(FDr BLu BUr) 5s 3s 6s 6s 3s.

[[$FB^2, L'R$], blr^2u'] (24 moves): (FUl LBd BRd)(FUr BDr LDl DFr UBr ULb RUB DRb)(FLu LBu BRu RFu)(FLd RFd ULf RUf)(FDl BUl Rdf DLf) 3s 8s 4s 4s 4s.

[[$FB, L'R$], blr^2u'] (24 moves): (FUl UFr DBr FDr BUr)(FLu LBu BRu RFu)(FLd RFd BRd LBd)(FDl BUl DBl)(LUb DRf LDf RDb RUf DLb ULf) 5s 4s 4s 3s 7s.

[[$FB, R'U$], $fb'r'ud'$] (26 moves): (FUl BDI LFu UFr FDr URb)(FRu LDf UBl BRd)(FLd RFd DLb DBr)(BUr RBu BLu LUb DRf RUf)(BLd LUf DRb) 6s 4s 4s 6s 3s.

[[FB, RU], $fb^2l^2ru^2$] (26 moves): (FUl LFu ULf RBu FLd)(FUr BDr LDl FRd RUB LBu)(FRu DRf RUf)(FDl DRb BUl DLf DBl)(FDr BRd BUr

LUb) 5s 6s 3s 5s 4s.

$[[R'F^2, D^2B'U^2], f^2b^2ru^2]$ (28 moves): (FUl DF1 DRf ULf LBd)(FUr DFr BDr UBr RBd)(FLu ULb DRb BRu BUl)(FRu DLb BDI URb BLu)(FRd DLf URf) 5s 5s 5s 5s 3s.

$[[FR^2, U^2D^2], br^2ud^2]$ (24 moves): (FUl RBu BDI UBl LFu DF1 FRu)(FUr BDr FRd BLd)(FLd BRd FDr BUr)(LUb URb RDb DLb)(LUf URf RDf DLf) 7s 4s 4s 4s 4s.

$[[FB^2, RU'], fb^2lu^2d^2]$ (26 moves): (FUl UBl DLb FLd)(FUr BDr RBd RUB DBl FDI)(FLu BRu LBu DRb)(FRu DRf LBd LDf LUb)(FRd URf UBr LUf) 4s 6s 4s 5s 4s.

$[[F^2R, L^2D^2], fblr^2d]$ (26 moves): (FUl FDr BDI DBr)(FUr UBr BUl FDI)(FLu RFu RBd RDf LUf)(FLd LBd LDf RUf RFd)(BRu DRb ULb RUB LDb) 4s 4s 5s 5s 5s.

23 edge pieces, 7 cycles

$[[FR^2, F'D^2], fbru^2d^2]$ (26 moves): (FUl FRu DBr BUr RBu UFr RFd DF1 LBd FDr BLu)(FLu DBl)(FLd BRd)(LUb RUf)(LUf RDf)(LDb RUB)(LDF RDb) 11s 2s 2s 2s 2s 2s 2s.

$[[FRB', D^2], bl^2r^2u^2d^2]$ (26 moves): (FUl BUr)(FUr BUl)(FLu DLf BRu LBu DRb LDb RBd LFd ULb RDf)(FRu URb)(FRd BLd URf)(FDI BDr)(FDr BDI) 2s 2s 10s 2s 3s 2s 2s.

$[[FR^2, F'D^2], fbru^2d']$ (26 moves): (FUl FRu FDr FLd RFd DF1 BRd LBd BLu)(FUr BDr UBr BRu)(FLu DBl)(LUb RUf)(LUf RDf)(LDb RUB)(LDF RDb) 9s 4s 2s 2s 2s 2s 2s.

$[[FB^2, RU'], f^2b^2r^2u^2d^2]$ (26 moves): (FUl RBu RUf FDr BDI BUr LDf LFu)(FUr BDr)(FRu LUb)(FLd BRd URb UBl DLb)(FRd LUf)(BLu RDb)(BLd RDf) 8s 2s 2s 5s 2s 2s 2s.

$[[FB^2, R'D'], f^2b^2rud]$ (26 moves): (FUl BDI)(FUr UBr)(FLu LUf FRd LFd BDr DFr)(FRu LDf UBl RBu RDb LBd DF1)(BLu LUb)(BRd DRf)(LDb RUB) 2s 2s 6s 7s 2s 2s 2s.

$[[FU'B', L'R], f^2b^2l^2d']$ (28 moves): (FUl RBu BDI)(FUr BLd RBd)(FLu RDf FDI BUl LUf BDr DLf DFr URf)(FRu BLu)(FLd RFd)(LUb RDb)(LDb RUB) 3s 3s 9s 2s 2s 2s 2s.

$[[FR^2, U^2D^2], b^2ru^2d']$ (24 moves): (FUl DF1 BLu BDI FRu RBu UBl

LFu)(FUr DFr BDr)(FLd RFd BRd BUr)(LUb RDb)(LUf Rdf)(LDb
 RUb)(Ldf RUf) 8s 3s 4s 2s 2s 2s 2s.

[[$FB R', U^2$], $f^2 b^2 r u d$] (26 moves): (FUl RDb Ldf BUr UFr FDr UB1)(FLu
 BRu)(FRu BLu)(FLd BRd)(FRd BLd)(BDr URf ULb)(BDl URb ULf DRf
 DLb) 7s 2s 2s 2s 2s 3s 5s.

[[FR, BD^2], $bl^2 r^2 u^2 d^2$] (26 moves): (FUl LUb DRf Lfu RUf Rbu)(FUr DLf
 BDr)(FRu FDr)(FLd RDb DLb BDl URb BRd)(FRd Fdl)(BUr BLu)(BUl
 BLd) 6s 3s 2s 6s 2s 2s 2s.

[[$FB^2, L'R$], $b^2 l r^2 u^2$] (24 moves): (FUl BRd UB1 DRf Ldf Dfl LBd)(FUr
 BDr ULb DRb)(FLu BRu)(FRu BLu)(FLd ULf)(FRd URf)(FDr BUr URb
 DLb) 7s 4s 2s 2s 2s 2s 4s.

[[$FB, L'R$], $b^2 l r' u^2 d$] (26 moves): (FUl DBr)(FUr Fdl Dfr Ubr BUl)(FLu
 BRu)(FRu BLu)(FLd RFd BRd LBd)(LUb DRf Ldf DLb RUf ULf)(RUb
 DRb) 2s 5s 2s 2s 4s 6s 2s.

[[$F^2 R, L^2 D^2$], $f b l r d$] (26 moves): (FUl BUr)(FUr BDr)(FLu RFu RBd Rdf
 LUf)(FLd LBd Ldf RUf RFd)(Fdl BUl)(Fdr BDl)(BRu DRb ULb RUb
 LDb) 2s 2s 5s 5s 2s 2s 5s.

[[$FB^2, R'U$], $f^2 b^2 l r^2 d^2$] (26 moves): (FUl UB1 FLd)(FUr ULb)(FLu Rdf
 LUf)(FRu URb DLb)(FRd URf)(Fdl DRb BDr RBd DBl Ubr BRu
 Dfr)(BLd Dlf) 3s 2s 3s 3s 2s 8s 2s.

[[$FB, L'R$], $bl r^2 u' d'$] (26 moves): (FUl Ufr BUr)(FLu Lbu BRu RFu)(FLd
 BRd)(FRd BLd)(Fdl BUl)(Fdr BDl Dbr)(LUb DRf Ldf Rdb RUf DLb
 ULf) 3s 4s 2s 2s 2s 3s 7s.

[[$FB^2, R'D'$], $f b^2 l^2 r' u$] (26 moves): (FUl BRd)(FUr Dfr)(FLu URf BRu
 DRb ULb Lbu)(FRu Dfl)(FRd RUb BDr Ubr Ldb)(BUl Rdf BLd)(BDl
 Ldf ULf) 2s 2s 6s 2s 5s 3s 3s.

[[$FB, L'R$], $bl r' u^2$] (24 moves): (FUl DBr)(FUr Ubr BUl DBl Fdl
 Dfr)(FLu BRu)(FRu BLu)(FLd RFd BRd LBd)(LUb DRf Ldf Rdb)(LUf
 LDb URf) 2s 6s 2s 2s 4s 4s 3s.

[[$FB, L'R$], $bl^2 r' u d'$] (26 moves): (FUl UB1)(FLu RFu BRu Lbu)(FLd
 BRd)(FRd BLd)(Fdl BDr DBl Ubr Dfr)(LUb Ldf URb DRf Rdb)(LUf
 LDb URf) 2s 4s 2s 2s 5s 5s 3s.

[[FB, LR], $l r^2 u d'$] (24 moves): (FUr Ubr)(FLu RFu BRu Lbu)(FLd RFd
 BRd LBd)(Fdl Dfr DBl BDr BUl)(LUb URb Ldf DRf)(LUf LDb)(RUf

RD_b) 2s 4s 4s 5s 4s 2s 2s.

$[[FB^2, R'U], fb^2l^2r'u^2]$ (26 moves): (FU_l RU_f UL_f)(FU_r UB_r FL_u)(FR_u UR_b)(FL_d RD_b LU_b)(FR_d RB_d RD_f DB_l BR_u BDR BU_l)(FD_l DFR DL_f)(BL_u DL_b) 3s 3s 2s 3s 7s 3s 2s.

$[[FB^2, RU'], f^2b^2ru'd']$ (26 moves): (FU_l DB_r BU_r RD_b LF_u BD_l)(FU_r DFR LB_u)(FR_u LU_b LD_f)(FL_d RF_d UL_f UB_l)(BR_u UR_f)(BR_d UR_b DR_f)(BL_d LD_b) 6s 3s 3s 4s 2s 3s 2s.

$[[FB'R, D^2], f^2b^2lr'u^2]$ (28 moves): (FU_l FDR RU_f LU_b BD_l)(FU_r FDI RU_b LU_f BDR)(FR_u BR_d)(FL_d RB_u RF_d)(BU_r DR_f DL_b)(BU_l DR_b DL_f)(BL_u LB_d) 5s 5s 2s 3s 3s 3s 2s.

$[[FB', RU], fblr^2]$ (24 moves): (FU_l UB_l BD_l LB_d FL_d)(FU_r BDR FL_u)(FR_u DR_f RU_f RB_u)(FR_d RB_d DR_b LD_b)(FDR BL_u BU_r)(LU_b UR_b)(LU_f DL_f) 5s 3s 4s 4s 3s 2s 2s.

$[[FB^2, L'R], bl^2r'u^2]$ (24 moves): (FU_l BR_d BD_l DR_f)(FU_r UB_r LD_b DFR)(FL_u BR_u)(FR_u BL_u)(FL_d RF_d UL_f RU_f)(FD_l BL_d BU_l DL_f)(LU_b UR_b RD_b) 4s 4s 2s 2s 4s 4s 3s.

$[[FB^2R, D^2], f^2b^2rud]$ (26 moves): (FU_r BR_u)(FL_u RU_b LU_f)(FR_u DF_l BD_l FDR DB_r BU_r)(FL_d UB_l RF_d)(BL_u DR_f DL_b)(BR_d RU_f LU_b)(BL_d DR_b DL_f) 2s 3s 6s 3s 3s 3s 3s.

$[[FB^2, R'D], fbl^2r^2d']$ (26 moves): (FU_l BR_d BU_r RD_b BL_u)(FU_r RF_u BDR)(FL_d DL_b LB_d)(FR_d DB_l)(FD_l BR_u RD_f UR_f)(FDR LD_f UR_b)(BU_l LU_f UL_b) 5s 3s 3s 2s 4s 3s 3s.

$[[FB, RU'], fb^2lr^2u]$ (26 moves): (FU_l RB_u FL_d)(FU_r RU_b LB_u)(FL_u LU_f)(FR_u DR_f RF_d RU_f)(FD_l LD_b BDR DB_l)(FDR BR_d BU_r)(BU_l DL_f UL_b DR_b) 3s 3s 2s 4s 4s 3s 4s.

$[[FB, R], fb^2lru^2d^2]$ (24 moves): (FU_l FR_u DR_f)(FU_r FR_d DR_b)(FL_u UB_r LU_f)(FL_d DF_l DL_b)(FDR LU_b LB_d)(BU_l UR_f BDR BR_u LB_u)(BR_d UR_b BD_l) 3s 3s 3s 3s 3s 5s 3s.

$[[R^2B'D', L^2F], fl^2r^2u^2]$ (28 moves): (FU_l BD_l LU_b)(FU_r BL_d BDR)(FL_u FR_d BR_u)(FR_u FL_d BL_u)(FD_l BU_l RU_b)(FDR DL_b BR_d RU_f)(BU_r UL_f LD_f DR_f) 3s 3s 3s 3s 3s 4s 4s.

23 edge pieces, 9 cycles

$[[D'LR^2, U'F'], b^2lr^2u]$ (28 moves): (FU_l LB_d RU_f RF_d UB_l DR_f BR_d)(FU_r

LDb)(FLu RFu)(FLd ULf)(FDl DBl)(FDr BUr)(BRu LBU)(BDr
 RUB)(LUB RDb) 7s 2s 2s 2s 2s 2s 2s 2s.

$[[UB^2L^2, UR'], fbl'r'u^2d]$ (32 moves): (FUl RFd)(FUr RBd LUf)(FLu BDr
 RDf LBU FDI RUB)(FRu RUf)(FDr LUB)(BUR RBu)(BUI LDb)(BLd
 DRb)(BDl LDf) 2s 3s 6s 2s 2s 2s 2s 2s.

$[[FB^2, RD^2], fb^2l^2r^2ud]$ (28 moves): (FUl FRu)(FUr FLu LDb FRd)(FLd
 DBr)(FDl ULb)(FDr RUf LBd BDl RBu)(BUR DRf)(BUI DRb)(BLu
 ULf)(BRd URb) 2s 4s 2s 2s 5s 2s 2s 2s.

$[[FB, L'R], bl^2r'u^2d']$ (26 moves): (FUl DBr UBl)(FLu BRu)(FRu
 BLu)(FLd BRd)(FRd BLd)(FDl DFr)(BUR BDl)(LUB LDf URb DRf
 RDb)(LUF LDb URf) 3s 2s 2s 2s 2s 2s 2s 5s 3s.

$[[FB, LR], lr^2ud^2]$ (24 moves): (FUr DBl UBr)(FLu RFu BRu LBU)(FLd
 BRd)(FRd BLd)(FDl DFr)(BUI BDr)(LUB URb LDf DRf)(LUF LDb)(RUF
 RDb) 3s 4s 2s 2s 2s 2s 4s 2s 2s.

$[[FB, L'R], fb^2l^2r'u^2d']$ (28 moves): (FUl DBr UBl)(FLu RFu BRu
 LBU)(FLd BRd)(FRd BLd)(FDl DFr)(BUR BDl)(LUB DRf RDb)(LUF
 LDb)(LDf URb RUf) 3s 4s 2s 2s 2s 2s 3s 2s 3s.

$[[FB^2R, L'U'], f^2b^2r'u^2d^2]$ (30 moves): (FUl BDl DLb)(FUr UBr)(FLu DRb
 FRd)(FRu FLd DRf)(FDl BUI)(FDr DBr)(BRu BLd ULb)(BLu ULf
 BRd)(LDf RUf) 3s 2s 3s 3s 2s 2s 3s 3s 2s.

23 edge pieces, 11 cycles

$[[FR^2, U^2D^2], b^2l^2r^2ud^2]$ (26 moves): (FUl RBu)(FUr BLd)(FLu BUI)(FRu
 BDl DF1)(FLd BUR)(FRd BDr)(FDr BRd)(LUB RDb)(LUF RDf)(LDb
 RUB)(LDf RUf) 2s 2s 2s 3s 2s 2s 2s 2s 2s 2s.

24 edge pieces, 2 cycles

$[[FB^2, RU], fblr^2u']$ (26 moves): (FUl DLb RFd BRd FDr DF1 URb UBl
 FRu DRf RUf ULf BLu RBu LFu LDf BDl BUR LUB UFr DBr FLd)(BLd
 DRb) 22s 2s.

$[[FB^2, RU], fb^2l^2r'd]$ (26 moves): (FUl BDl LFu UFr RUf BUR FLd RDb
 LUB LBd BRd URb DLb RFd DBr UBl RBu FRu DRf BLu ULf)(FDl DFr
 DLf) 21s 3s.

$[[FB^2, RU], fb^2l'ru']$ (26 moves): (FUl LUB BDl LDf)(FUr DFr LBU BRu

FLu BUl RFu RDf URf LUf BDr DRb BLd LDb RBd RUb FDI LfD UBr FRd) 4s 20s.

$[[FB^2, RU], fb^2lr^2u']$ (26 moves): (FUl LUb UFr DBr FLd)(FLu DLf DBl UBr FRd DFr FDI DRb BLd LDb RBd RUb BUl RFu RDf URf LUf LBu BRu) 5s 19s.

$[[FB^2, RU], fb^2l^2r^2u^2]$ (26 moves): (FUl LBd UBl LFu LDf BDI BUr RFd FDr DF1 RDb DLb BRd URb LUb UFr DBr FLd)(FRu DRf RUf ULf RBu BLu) 18s 6s.

$[[FB^2, RU], fb^2l^2rd]$ (26 moves): (FUl BDI LDf DF1 BUr FLd RDb LUb LBd BRd URb DLb RFd UFr RUf FDr LFu)(FRu DRf BLu ULf DBr UBl RBu) 17s 7s.

$[[FB^2, RU], fb^2l'r^2d]$ (26 moves): (FUl DF1 LBd BRd URb DLb RFd FDr UBl RBu FRu DRf BLu ULf LFu LDf)(FUr URf BDr DRb ULb DBl UBr LFd) 16s 8s.

$[[FB^2, RU], fb^2lr'u^2]$ (26 moves): (FUl LBd UBl LFu UFr BUr RFd DBr FLd)(FRu DRf RUf ULf DF1 RDb DLb BRd URb LUb FDr LDf BDI RBu BLu) 9s 15s.

$[[FB^2, RU], f^2b^2lrd^2]$ (26 moves): (FUl UBl FRu BDI DRf LDf RBu RUf ULf DBr BRd URb DLb FLd)(FUr LBu DFr FLu FDI DRb ULb UBr BLd FRd) 14s 10s.

$[[FB^2, RU], fb^2lr'u']$ (26 moves): (FUl LUb FDr LDf BDI BLu RBu LFu UFr BUr RFd DBr FLd)(FRu DRf RUf ULf DF1 RDb LBd DLb BRd URb UBl) 13s 11s.

$[[FR, U^2D^2], br^2ud]$ (24 moves): (FUl RUf DRf BLu LDf BDI UBl LFu DF1 FRu ULf RBu)(FUr BDr ULb RUb DRb LDb RBd FRd LFd BLd DFr UBr) 12s 12s.

24 edge pieces, 4 cycles

$[[FB^2, RU], fblrd']$ (26 moves): (FUl UBl RBu FRu DRf FDr LFu DF1 URb RDb DLb BRd UFr ULf DBr RFd LBd FLd)(BUr LUb)(BLu RUf)(BDl LDf) 18s 2s 2s 2s.

$[[FB^2, R'U'], fblr^2d']$ (26 moves): (FUl UBl DBr RFd LBd UFr URb LUb DLb RBu FRu RDb BDI BUr FDr DF1 FLd)(FLu LBu)(BRd DRf RUf)(LUf DLf) 17s 2s 3s 2s.

$[[FB^2, RU], fb^2lrd']$ (26 moves): (FUl UB_l RB_u FR_u DR_f FD_r LF_u DF_l RD_b LU_b BU_r BR_d UR_b DL_b LB_d FL_d)(FU_r LU_f BD_r FR_d)(BL_u RU_f)(BD_l LD_f) 16s 4s 2s 2s.

$[[FB^2, RD], fbrud]$ (26 moves): (FUl FR_u DL_b RF_d FL_d FD_r LD_f DBr UL_f BL_u LF_u RD_b BR_d UR_b BD_l)(FU_r UB_r)(FD_l UL_b)(BU_l BR_u RD_f UR_f BL_d) 15s 2s 2s 5s.

$[[FB^2, R'U'], fb^2lru]$ (26 moves): (FUl LD_f UL_f RU_f RF_d BR_d DR_f UFr FD_r FR_u UR_b BL_u DBr FL_d)(FL_u FD_l BL_d UB_r BU_l DB_l)(BR_u LD_b)(LU_b RD_b) 14s 6s 2s 2s.

$[[FB, RU], fb^2l^2r^2u^2d^2]$ (28 moves): (FUl UFr)(FL_u LU_f LB_u UL_b RU_b RB_d UB_r BL_d UR_f BR_u BU_l DL_f FD_l)(FR_u DR_f RF_d FD_r FL_d DL_b RD_b)(BD_r DB_l) 2s 13s 7s 2s.

$[[FB^2, RU^2], f^2b^2lrd]$ (26 moves): (FUl UB_l UL_f FR_u DR_f LF_u DBr BU_r)(FU_r LB_u DL_f BR_u UR_f FD_l BL_d RB_d RU_b LD_b FR_d DR_b)(FL_d LU_b)(FD_r BD_l) 8s 12s 2s 2s.

$[[FB^2, RU], fb^2lr'd']$ (26 moves): (FUl UB_l RB_u FR_u DR_f BU_r BR_d UR_b DL_b LB_d FL_d)(FU_r LU_f FD_l DR_b UL_b DF_r DL_f DB_l FL_u)(FR_d BDr)(BL_u RU_f) 11s 9s 2s 2s.

$[[FR, U^2D^2], bru^2d^2]$ (24 moves): (FUl RU_f DR_f LF_u UL_f DF_l BL_u BD_l FR_u RB_u)(FU_r DF_r BDr FR_d BL_d UB_r UL_b RU_b DR_b LD_b)(FL_d BR_d)(BU_l DL_f) 10s 10s 2s 2s.

$[[FB^2, RU'], fb^2lrd']$ (26 moves): (FUl DBr RF_d RU_f BL_u UFr BU_r RD_b RB_u FR_u DR_f BR_d UR_b DL_b LB_d FL_d)(FL_u FD_l DF_r)(BU_l DB_l)(LU_b UL_f LD_f) 16s 3s 2s 3s.

$[[FB^2, RD], fbr^2u^2d^2]$ (26 moves): (FUl RD_b UB_l DL_b FL_d UFr UL_f LF_u BD_l RB_u DR_f RU_f DBr BR_d UR_b)(FR_u RF_d LB_d BL_u)(FD_l UL_b)(FD_r LD_f BU_r) 15s 4s 2s 3s.

$[[FB^2, RU], fb^2lr'd']$ (26 moves): (FUl BD_l LF_u UFr UL_f)(FR_u DR_f BU_r LU_b RF_d LB_d FL_d UR_b RD_b DL_b BR_d DBr UB_l RB_u)(FD_l DF_r DL_f)(BL_u RU_f) 5s 14s 3s 2s.

$[[FB^2, RU'], fb^2lrd]$ (26 moves): (FUl DBr LB_d BR_d UR_b DL_b RF_d RU_f RD_b RB_u FR_u DR_f FL_d)(FU_r UB_r LB_u LU_f DL_f UL_b)(FL_u FD_l DF_r)(BU_l DB_l) 13s 6s 3s 2s.

$[[FB^2, RU'], fblrd^2]$ (26 moves): (FUl DBr BR_d RU_f UFr BU_r UL_f LD_f

DLb LBd RFd FLd)(FLu FDI DFr)(FRu DRf LUb BLu URb RDb
 RBu)(BUl DBl) 12s 3s 7s 2s.

[[FB^2, RD], fbr^2ud^2] (26 moves): (FUl FRu RFd LBd RBu DRf RUf DBr
 BRd URb BDI)(FUr LUf LBu FLu DRb BUl LDb LfD)(FDl ULb)(FDr
 LDf BUr) 11s 8s 2s 3s.

[[FR, U^2D^2], bru^2d'] (24 moves): (FUl RUf DRf LFu ULf DF1 BLu BDI
 FRu RBu)(FUr DFr BDr)(FLd RFd BRd LBd LUb URb RDb DLb
 BUr)(BUl DLf) 10s 3s 9s 2s.

[[$FB^2, R'U'$], $fb^2lr'd^2$] (26 moves): (FUl UBl RDb BUr DBr BRd DRf RUf
 LBd FDr BLu DF1 RFd FLd)(FUr ULb DBl FLu)(FRu URb RBu
 DLb)(LUf DLf) 14s 4s 4s 2s.

[[FB^2, RD], $fb^2r'u'd'$] (26 moves): (FUl BDI DLb RDb LFu)(FUr FRd RBd
 FDI BLd ULb RUb LBu BRu Rdf URf DFr DLf)(FRu UBl FLd ULf)(BUr
 DBr) 5s 13s 4s 2s.

[[FR, U^2D^2], br^2ud^2] (24 moves): (FUl RUf DRf BLu LDf BDI UBl LFu
 DF1 FRu ULf RBu)(FUr BDr FRd BLd)(FLd BRd)(FDr BUr LUb URb
 RDb DLb) 12s 4s 2s 6s.

[[FB^2, RD], $fb^2l'u^2d'$] (26 moves): (FUl DLb RDb LUb URb DF1 LBd FLd
 ULf LFu UBl)(FUr FRd URf BDr)(FRu BLu BUr BRd BDI RBu
 DRf)(FDr LDf) 11s 4s 7s 2s.

[[$FB^2, L'R$], $bl^2r^2u'd^2$] (26 moves): (FUl RFd ULf RUf BRd UBl LDf DF1
 BDI DRf)(FUr RFu FLu LBu UBr ULb RUb DRb)(FLd LBd)(FDr RBu
 DBr DLb) 10s 8s 2s 4s.

[[$FB^2, R'U'$], $f^2b^2lrd^2$] (26 moves): (FUl UBl RDb FDr LFu DF1 RFd RUf
 FLd)(FUr ULb DBl LBu BDr RBd DLf BLd UBr)(FRu URb RBu
 DLb)(LUf Rdf) 9s 9s 4s 2s.

[[FB^2, RU], fb^2r^2d'] (26 moves): (FUl BDI BUr LUb RFd LBd FLd URb
 RDb DLb BRd FDr)(FUr LUf FLu DLf FDI)(FRu DRf DBr UBl
 RBu)(BLu RUf) 12s 5s 5s 2s.

[[FB^2, RU], $fb'lrd$] (26 moves): (FUl UBl RBu FRu DRf BLu ULf DBr
 LBd BRd FLd)(FUr URf DFr FLu FDI LDb)(FRd DRb RUb ULb
 UBr)(BDI LDf) 11s 6s 5s 2s.

[[FB^2, RU], $fb'l'r'd'$] (26 moves): (FUl DF1 RFd LBd FLd FDr LDf)(FUr
 LUf BUl BRu RFu Rdf UBr ULb DBl FLu)(BLu RUf)(BRd DBr URb

RDb DLb) 7s 10s 2s 5s.

$[[FB^2, RD], f^2b^2rud]$ (26 moves): (FUl FRu LUb URb BDI)(FUr UBr)(FLu LDb DRb RBd FDI FRd LFd DFr LBu)(BUl BRu BDr DLf RDf LUf URf BLd) 5s 2s 9s 8s.

$[[FB^2, RU], fb^2l'rd']$ (26 moves): (FUl DF1 RFd UFr ULf DBr RDb LUb BDI LDf)(FLu BUl BRu RFu RDf DFr)(FLd BUr BRd URb DLb LBd)(BLu RUf) 10s 6s 6s 2s.

$[[FB^2, RU], fblr^2d']$ (26 moves): (FUl UBl RBu FRu DRf DBr RFd LBd FLd)(FUr LUf FLu DLf DBl UBr ULb)(FDl RUb DRb LDb RBd DFr)(BLu RUf) 9s 7s 6s 2s.

$[[FB, RU], fblr'u^2d^2]$ (28 moves): (FUl FDr ULf BLu DLb LBd RUf FLd)(FUr FDI DRb RFu RDf FRd RUB FLu)(BUr LUb DBr UBl LDf BDI)(BRu RBd) 8s 8s 6s 2s.

$[[FB^2, RD], fb'r'ud^2]$ (26 moves): (FUl FRu UBl RFd LBd URb BDI)(FUr LUf LBu FLu ULb LFd DFr DLf)(FDl LDb)(BUr DBr BRd RDb RBu DRf RUf) 7s 8s 2s 7s.

$[[FB', RU'], fb^2l^2r^2d^2]$ (26 moves): (FUl DLb FLd)(FUr BDr FLu)(FRu DRf LBd UBl DF1 RFd RUf ULf LDf LUb FDr BLu BUr RDb RBu)(BRd URb BDI) 3s 3s 15s 3s.

$[[FB, RU], fblrud^2]$ (28 moves): (FUl LFu FLd)(FUr FDI DRb BUl DLf DBl DFr RFu RDf FRd RUB LBu UBr ULb)(BRu RBd LUf)(BLd URf BDr LDb) 3s 14s 3s 4s.

$[[FB^2, RD'], f^2b^2r^2u^2d]$ (26 moves): (FUl DLb URb)(FUr FDI DLf LBu DRb BUl ULb RFu URf BLd RDf LUf RBd)(FLu UBr DFr BRu DBl)(FLd DBr RFd) 3s 13s 5s 3s.

$[[FB^2, RD'], fb^2r^2u^2d']$ (26 moves): (FUl DLb URb)(FUr FRd RBd)(FLu UBr DFr BRu LFd LUf)(FRu DRf RUf DF1 DBr LBd BDI LDf BLu RDb UBl LUb) 3s 3s 6s 12s.

$[[FB^2, R'D'], fb'ru'd^2]$ (26 moves): (FUl FLd RBu BUr UFr FRu ULf)(FLu FDI FRd BLd URf RDf LBu RBd DBl DLf BUl)(FDr URb LUb)(BDr LDb DRb) 7s 11s 3s 3s.

$[[FB^2, RD'], fb^2r^2u^2d]$ (26 moves): (FUl DLb URb)(FUr FDI LUf FLu UBr DFr BRu RBd)(FRu DRf RUf LBd BDI LDf BLu RDb UBl LUb)(FLd DBr RFd) 3s 8s 10s 3s.

$[[FR, U^2D^2], bru'd']$ (24 moves): (FUl RUf DRf FRu BLu UBl BDI LDf RBu)(FUr DFr BDr)(FLu LUf FDI)(FLd RFd BRd LBd LUb URb RDd DLb BUr) 9s 3s 3s 9s.

$[[FB^2, RD^2], f^2b^2r^2ud^2]$ (26 moves): (FUl FRu BDI RBu RUf DBr UFr LDf BLu BRd URb RFd LBd)(FLu LDd Lfd)(FDl ULb BUl DRb)(FDr BUr DRf ULf) 13s 3s 4s 4s.

$[[FB^2, RU'], fb^2lr'd']$ (26 moves): (FUl DFl BUr RDd RBu FRu DRf BRd URb DLb LBd FLd)(FUr DFr BUl DBl FLu)(FRd URf LBu BDr)(LUb ULf LDf) 12s 5s 4s 3s.

$[[FB^2, RD], fb^2r^2u^2d^2]$ (26 moves): (FUl DLb RDd UBl LUb URb)(FUr LUf FLu DBl BRu RDf URf BDr RBd FDI Lfd)(FRu RFd LBd BLu)(FDr LDf BUr) 6s 11s 4s 3s.

$[[FB, RU], fb^2lr^2u^2d']$ (28 moves): (FUl UFr FLd)(FLu LUf LBu RUB)(FRu DRf DBr UBl LDf BDI RUf RBu RFd RDd)(FDl ULb RBd UBr LDd DFr BLd) 3s 4s 10s 7s.

$[[FB, RU^2], f^2b^2lr^2u^2d^2]$ (28 moves): (FUl FRu DRf BUr)(FUr FRd DRb DFr LUf LBu BUl DLf BRu)(FLu URf DBl Lfd RUb ULb BLd BDr)(FDl LDd RBd) 4s 9s 8s 3s.

$[[FB^2, RD'], fb^2r^2ud^2]$ (26 moves): (FUl FRu DRf RUf DBr DLb RDd UBl URb BUr FDr)(FUr LUf LBu)(FLu ULb Lfd FDI RBd)(FRd BLd DBl DLf BRu) 11s 3s 5s 5s.

$[[FB^2, RU'], fb^2l'r'd']$ (26 moves): (FUl DBr FDr LFu UBl)(FUr DBl FDI FRd URf LBu)(FRu DRf BRd URb DLb LBd FLd BUr RDd RBu)(LUb ULf LDf) 5s 6s 10s 3s.

$[[FB^2, LR], bl^2r^2u^2d']$ (26 moves): (FUl LBd UBl LDf DFl FLd BRd BDI DRf)(FUr UBr ULb RUB DRb)(FLu BRu RFu LBu BDr LDd DFr)(FRd LUf URf) 9s 5s 7s 3s.

$[[FB, LR], blr^2u^2d^2]$ (26 moves): (FUl FDr DFl UFr BDI BUr UBl DBr)(FLu RFu LBu BLd FRd Lfd RBd BRu)(LUb RDd RUf DLb ULf)(LDf DRf URb) 8s 8s 5s 3s.

$[[FB^2, RU], fb^2l^2r'u^2]$ (26 moves): (FUl LBd BDI RBu BLu FRu DRf RUf ULf)(FUr UBr FRd BDr BUl FLu)(FLd RDd DLb BRd URb LUb)(FDl DFr DLf) 9s 6s 6s 3s.

$[[FB^2, RD'], fbr'u^2d^2]$ (26 moves): (FUl RDd BLu FLd DFl BRd

URb)(FU_r LU_f FL_u)(FR_u UB_l DR_f RU_f BU_r DBr)(FR_d BL_d DB_l DL_f
 LD_b UL_b DFr BR_u) 7s 3s 6s 8s.

[[FB, RU], $fb^2l^2r'ud^2$] (28 moves): (FU_l LF_u UFr)(FR_u DR_f RF_d DBr LU_b
 UR_b BR_d)(FL_d DL_b RDb BD_l BU_r LB_d RU_f)(FD_l LB_u DFr LU_f BR_u
 BU_l DL_f) 3s 7s 7s 7s.

[[FB, RU], $fb^2lr^2u^2d^2$] (28 moves): (FU_l UFr DF_l LU_b LB_d RU_f RB_u BR_d
 BU_r DL_b FDr FL_d)(FL_u LU_f LB_u RU_b)(FR_u DR_f RF_d RDb)(BU_l DL_f
 DB_l BDr) 12s 4s 4s 4s.

[[FB^2, RU'], $f^2b^2lr'd^2$] (26 moves): (FU_l DF_l BU_r LDF RB_u RU_f DBr BR_d
 UR_b DL_b FL_d)(FU_r DFr BU_l DB_l FL_u)(FR_u LU_b BL_u RDb)(FR_d LU_f
 RD_f BL_d) 11s 5s 4s 4s.

[[FB^2, RD'], $f^2b^2ru'd^2$] (26 moves): (FU_l DBr FL_d DF_l BR_d BU_r UFr LDF
 UB_l LF_u)(FR_u LU_b RB_u BD_l)(FR_d BL_d RD_f LU_f)(FDr DL_b UR_b BL_u
 RDb RU_f) 10s 4s 4s 6s.

[[FB^2, RD'], $f^2b^2ru'd'$] (26 moves): (FU_l DBr LB_d DR_f UL_f FL_d LDF UB_l
 LF_u)(FU_r FR_d RB_d UBr)(FR_u LU_b RB_u BD_l)(FD_l DFr LD_b RU_b LB_u
 DR_b UR_f) 9s 4s 4s 7s.

[[$FB, L'R$], bl^2r^2u] (24 moves): (FU_l UB_l DF_l FDr BU_r UFr DBr BD_l)(FL_u
 RF_u BR_u LB_u)(FL_d RF_d BR_d LB_d)(LU_b LDF UR_b DR_f RDb RU_f DL_b
 UL_f) 8s 4s 4s 8s.

[[FB^2, RD'], $fb^2l^2u^2d'$] (26 moves): (FU_l DL_b BR_d DBr LB_d)(FU_r FR_d
 RU_b DB_l DL_f RD_f UBr UR_f BU_l FD_l)(FL_u DFr BR_u LF_d LU_f)(FR_u BL_u
 RDb LU_b) 5s 10s 5s 4s.

[[FB^2, RD], $f^2b^2r^2u^2d^2$] (26 moves): (FU_l DL_b RDb UB_l LU_b UR_b)(FU_r
 DL_f RD_f LU_f UR_f BDr RB_d FD_l LF_d)(FL_u DB_l BR_u UBr DFr)(FR_u RF_d
 LB_d BL_u) 6s 9s 5s 4s.

[[FB^2, RD'], $fb^2ru'd'$] (26 moves): (FU_l DBr LB_d BD_l LDF UB_l LF_u)(FU_r
 FR_d RB_d UBr)(FR_u LU_b RB_u FL_d UL_f)(FD_l DFr LD_b RU_b LB_u DR_b
 RD_f UR_f) 7s 4s 5s 8s.

[[$FB^2, L'R$], $bl^2r^2ud^2$] (26 moves): (FU_l UB_l LDF DF_l FL_d LB_d BD_l
 DR_f)(FU_r LB_u UBr UL_b RU_b DR_b)(FL_u RF_u BR_u BDr LD_b DFr)(FR_d
 LU_f UR_f RB_d) 8s 6s 6s 4s.

[[FB, RU], $fblr'ud'$] (28 moves): (FU_l LF_u UFr FL_d)(FR_u DR_f BU_r LU_b
 DBr DL_b BR_d)(FR_d RU_b LB_u DFr LU_f BR_u)(FD_l DR_b BU_l DL_f DB_l UR_f

BLd) 4s 7s 6s 7s.

$[[R^2F'L, D^2B^2], fblrd]$ (30 moves): (FUl URb LFu DBr BUr)(FUr RFu
LDb ULb URf)(FLd ULf FDr BDI DRf)(FRd BUl DRb DLf LBu BRu FDI
BLd RBd) 5s 5s 5s 9s.

$[[FB, RU], fb'lru^2d']$ (28 moves): (FUl BUr DLb UFr FLd)(FLu BLd FDI
ULb RBd LUf LBu RUb)(FRu DRf FDr RBu RFd RDb)(BUl DLf DBI
URf BDr) 5s 8s 6s 5s.

$[[FB^2, L^2R], f^2b^2l^2r^2d']$ (26 moves): (FUl BDI ULf FRu DRf)(FUr LBu FLu
LDb UBr FRd DRb)(FLd LBd BRd FDr URb DBr LUb)(FDI URf DLf
BUl BRu) 5s 7s 7s 5s.

$[[FB^2, R'D'], fbr^2ud^2]$ (26 moves): (FUl FLd LFu RUf UBl ULf)(FUr RUb
DRb UBr DFr LDb ULb)(FRu DRf RFd LBd DFl)(BRu BDr LBu RBd
DBI DLf) 6s 7s 5s 6s.

$[[FB, L^2R], f^2b^2lrd^2]$ (26 moves): (FUl UBl DLb FLd BRd URb)(FUr FLu
DFr DLf BRu URf)(FRu DRf BDI BLu DFl ULf)(FRd DRb BDr UBr ULb
BLd) 6s 6s 6s 6s.

24 edge pieces, 6 cycles

$[[FB^2, R'U], f^2b^2lr^2u^2d^2]$ (28 moves): (FUl ULf RBu FDr DFl RDb DBr
BRd BDI BUr LFu DRf UBl FLd)(FUr ULb)(FRu URb)(FRd URf)(BLu
DLb)(BLd DLf) 14s 2s 2s 2s 2s 2s.

$[[FR^2, F'D^2], fblru^2d']$ (28 moves): (FUl FRu FDr FLd BDI LFu DFl BRd
BUr RBu UFr DBr RFd)(BUl BLd LBu)(LUb RUf)(LUf Rdf)(LDb
RUb)(Ldf RDb) 13s 3s 2s 2s 2s 2s.

$[[FB^2, R'U], f^2b^2lr'u^2d^2]$ (28 moves): (FUl ULf DFl RDb BUr LFu UFr
LUb FDr DRf UBl FLd)(FRu URb)(FRd URf)(BRu BDr RBd DBI)(BLu
DLb)(BLd DLf) 12s 2s 2s 4s 2s 2s.

$[[U^2D^2R^2, R^2F'], f^2r^2u'd']$ (28 moves): (FUl UFr RBu FRu LBd)(FLu BUl
LBu FDI DBI BDr UBr DFr LFd FRd RBd)(LUb RDb)(LUf Rdf)(LDb
RUb)(Ldf RUf) 5s 11s 2s 2s 2s 2s.

$[[FB^2, RU], fb^2l'ru^2d]$ (28 moves): (FUl BRd URb LUb BDI Ldf)(FUr URf
DFr BRu LBu LUf BDr DRb LDb FRd)(FLu BUl)(FRu DRf)(FLd
BUr)(FDI BLd) 6s 10s 2s 2s 2s 2s.

$[[B^2D'F^2, U'L^2], f'b'lu^2]$ (28 moves): (FUl BDI DFl UBl DLb URb

$(LUB)(FUr DFr URf DRb BDr RDf DLf LUf UBr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)$ 7s 9s 2s 2s 2s 2s.

$[[FB, L'R], b^2lr^2u^2]$ (24 moves): $(FUl FDr BUr UBl BDI DFl UFr DBr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUB DRf LDf DLb ULf URb RDb RUf)$ 8s 2s 2s 2s 2s 8s.

$[[FB, RU'], fb^2l'r'u^2d]$ (28 moves): $(FUl BLu)(FUr RUb DBl RBd BRu LDl UBr BUl RFu RDf LFd FLu)(FRd URf)(FDl BLd DRb)(FDr ULf)(BDr DLf ULb)$ 2s 12s 2s 3s 2s 3s.

$[[BUD, LR], f^2bl'r^2]$ (28 moves): $(FUl LFu BUr BRd FDr RFd DFl DBr LBd UFr BDI)(FRu FLd)(BUl LBU BRu)(LUB URb RDb DLb)(LUf RDf)(LDf RUf)$ 11s 2s 3s 4s 2s 2s.

$[[FB^2, R'U], fb^2l'r^2u^2d^2]$ (28 moves): $(FUl RUf RFd FLd UFr LUB BDI BUr LFu LDf)(FRu URb)(FDl RBd RDf)(FDr UBl LBd ULf RBu)(BLu DLb)(BDr DRb)$ 10s 2s 3s 5s 2s 2s.

$[[FB^2, R'U], fb^2lru^2d']$ (28 moves): $(FUl RUf FDr RBu UFr FLd)(FLu FDI DRb LUf BDr FRd BLd ULb UBr)(FRu URb)(BUl RBd RDf)(BLu DLb)(BDl LDf)$ 6s 9s 2s 3s 2s 2s.

$[[FR, U^2D^2], b^2ru^2d']$ (24 moves): $(FUl DRf)(FUr DFr BDr)(FLu LUf FDI LBU DBl RFu BRu URf)(FLd RFd BRd LBd URb DLb BUr)(BUl DLf)(LUB RDb)$ 2s 3s 8s 7s 2s 2s.

$[[FB^2, R'U'], fbl'r^2]$ (24 moves): $(FUl UBl BDI BUr FDr DFl LBd UFr DBr FLd)(FLu LBU)(FRu RDb DLb RBu)(FRd RBd RDf URf)(LUB URb)(LUf DLf)$ 10s 2s 4s 4s 2s 2s.

$[[FB^2, RD], fb'rud]$ (26 moves): $(FUl FRu URb BDI)(FUr UBr)(FLu ULb FRd LFd DFr DLf BDr LUf LBU)(FDl LDl)(BUl BRu RDf URf BLd)(BRd RDb)$ 4s 2s 9s 2s 5s 2s.

$[[FB, L'R], fb^2r^2u'd]$ (26 moves): $(FUl UFr BDI UBl BUr DFl)(FLu BRu)(FRu BLu)(FLd RFd BRd LBd)(FDr DBr)(LUB RDb ULf URb DLb LDf DRf RUf)$ 6s 2s 2s 4s 2s 8s.

$[[FB^2, R'D], fb^2l'ru'd]$ (28 moves): $(FUl UFr)(FLu UBr LFd BUl)(FRu ULf URb DFl DRf BLu LUB)(FRd LDl)(FDr LDf BDI RBu RDb LBd RUf)(BRd DBr)$ 2s 4s 7s 2s 7s 2s.

$[[F'L'B^2, U^2D], f^2b'ud]$ (28 moves): $(FUl FLd LBd DBr RFd)(FUr RDf LUf BRu DBl FLu RFu FDI)(FDr DLb RDb URb LUB)(BUr BRd)(BUl$

LBu)(LDf RUf) 5s 8s 5s 2s 2s 2s.

[[FB^2, RD'], $fb^2lru'd'$] (28 moves): (FUl DBr LBd DF1 FDr DLb RUf)(FUr FRd)(FLu BUl)(FRu LUb RBu FLd ULf)(BUr URb BLu RDb DRf BRd)(BDl LDf) 7s 2s 2s 5s 6s 2s.

[[FB, RU'], $fb^2lr'u^2d^2$] (28 moves): (FUl BLu BDl DLb RUf FLd)(FUr BLd BDr DLf RUb FLu)(FRu DRf BUr RFd RDb UBl)(FDl ULb)(FDr ULf)(BRu RBd) 6s 6s 6s 2s 2s 2s.

[[FB, RU'], $fb^2lr'u^2d$] (28 moves): (FUl BLu BDl BRd RBu LBd RDb UBl FRu DRf FLd)(FUr RUb FLu)(FRd URf)(FDl LDb UBr)(FDr ULf)(BDr DLf ULb) 11s 3s 2s 3s 2s 3s.

[[$FB^2, R'U'$], $fb^2l^2r^2u^2$] (26 moves): (FUl RUf RFd BRd DRf BDl BUr LDf ULf FDr)(FUr BDr BUl FDI)(FLu RFu RUB)(FLd LBd)(BRu LDb LBu)(LUB RDb) 10s 4s 3s 2s 3s 2s.

[[FB^2, RU'], $f^2b^2lr'ud$] (28 moves): (FUl DF1 BUr LFu UFr FDr UBl DRf FLd)(FRu LUb DBr LBd BDl)(FRd LUf LDb)(BRu URf DRb)(BLu LDf)(BRd URb) 9s 5s 3s 3s 2s 2s.

[[$FB^2, R'D'$], fb^2ru^2d'] (26 moves): (FUl LBd RBu RDb FRu ULf)(FUr UBr)(FLu LFd ULb)(FRd RBd DBl DLf BUl LBu BDr DFr)(FDl URf RDf)(LDb RUB) 6s 2s 3s 8s 3s 2s.

[[FR, U^2D^2], $b^2ru'd'$] (24 moves): (FUl DRf)(FUr DFr BDr)(FLu LUf FDI)(FRu BLu UBl BDl LDf RBu RUf)(FLd RFd BRd LBd URb DLb BUr)(LUB RDb) 2s 3s 3s 7s 7s 2s.

[[FR^2, D^2B^2], fb^2lru^2d'] (28 moves): (FUl BUr)(FUr BRu BUl RFu LFd FLu DFr DBl BLd)(FRd BDr)(FDl LBu RBd)(LUB ULf DRf URb)(LDb URf DRb DLf) 2s 9s 2s 3s 4s 4s.

[[$FB, L'R$], $bl^2r'u^2$] (24 moves): (FUl DBr UBl DF1 FDr UFr BUr BDl)(FLu BRu)(FRu BLu)(FLd RFd BRd LBd)(LUB LDf URb DRf RDb)(LUf LDb URf) 8s 2s 2s 4s 5s 3s.

[[FB, RU], $fb^2l^2r^2u'd'$] (28 moves): (FUl LUB URb RFd FDr LBd)(FUr LFd LDb DRb)(FLu LUf)(FRu DRf DBr RBu UBl LDf DF1)(BUr BRd)(BLu BDl RUf) 6s 4s 2s 7s 2s 3s.

[[FB^2, RU'], fb^2lrd] (26 moves): (FUl DBr LBd BRd FLd)(FUr UBr LBu LUf DLf RUB ULb)(FLu FDI DFr)(FRu DRf RFd RDb RBu)(BUl DBl)(LDb URf) 5s 7s 3s 5s 2s 2s.

$[[FR, F'D^2], f^2b^2lr^2u^2d']$ (28 moves): (FUl FRu DLb DBr RFd LDf)(FUr UBr FDI URf RBd RDf)(FLu ULb)(FLd BDI FDr)(BUl LUF BLd RUB LBu)(BRu DRb) 6s 6s 2s 3s 5s 2s.

$[[FB, L'R], bl^2r^2u^2]$ (24 moves): (FUl FDr BUr BDI)(FUr BDr BUl FDI)(FLu BRu)(FRu BLu)(FLd RFd BRd LBd)(LUB Ldf URb DRf RDb RUf DLb ULf) 4s 4s 2s 2s 4s 8s.

$[[FR, U^2D^2], fb^2l^2r'u^2d^2]$ (28 moves): (FUl RUf BLu DRf BDI DF1 LDf)(FUr LFd)(FLu BRu LUF RFu BUl)(FRd DRb LDb BDr)(FDr BRd LUb LBd)(BUr URb) 7s 2s 5s 4s 4s 2s.

$[[FB^2, R'U'], fblr]$ (24 moves): (FUl UBl BDI BLu DBr FLd)(FUr DFr FLu FDI BLd UBr)(FRu RDb DLb RBu)(FRd RBd RDf URf)(LUB URb)(LUF DLf) 6s 6s 4s 4s 2s 2s.

$[[FB, R'U'], fb'l^2r^2u^2d]$ (28 moves): (FUl FDr RFd UFr DF1 FRu)(FLu RUB)(FLd RUf)(BUr RBu UBl BRd)(BLu LDf ULf BDI RDb)(BLd LDb ULb BDr RDf) 6s 2s 2s 4s 5s 5s.

$[[FR, U^2D^2], blru^2d^2]$ (26 moves): (FUl RUf DRf LFu ULf)(FUr DFr RUB DRb LDb)(FRu RBu UBl LDf BDI)(FLd LBd BUr LUb BRd)(FRd BDr)(FDI LBu) 5s 5s 5s 5s 2s 2s.

$[[FB, RU'], f^2b^2lr'u^2d^2]$ (28 moves): (FUl RUf FLd)(FUr RUB FLu)(FRu LUb DF1 DLb BUr RFd ULf FDr LDf UBl)(BRu RDb)(BLu BDI RDb)(BLd BDr RDf) 3s 3s 10s 2s 3s 3s.

$[[L^2B'U, DF], l'rud^2]$ (28 moves): (FUl RDb DF1 RUf)(FUr ULb RDf BRu LBu FLu RFu DFr RUB)(FLd BRd)(FRd LUf BLd)(BUr DLb DBr)(BUl DLf DBI) 4s 9s 2s 3s 3s 3s.

$[[FB^2, RD'], fb'l^2r^2u^2d^2]$ (28 moves): (FUl LUb FLd)(FUr LUf FLu UBr DRb DBI DLf LBu)(FRu DRf LBd DF1 BRd)(FRd DFr BRu)(BUl RUB)(BDr LDb URf) 3s 8s 5s 3s 2s 3s.

$[[FB^2, R'D], fb^2lru^2d']$ (28 moves): (FUl DLb LBd RUf FDr LDf)(FUr DBI FRd)(FLu UBr BUl)(FRu ULf URb BRd DBr FLd LUb)(FDI RDf LBu)(BRu DRb) 6s 3s 3s 7s 3s 2s.

$[[FB, LR], blru^2d^2]$ (26 moves): (FUl UFr BDI DBr)(FLu RFu LBu BLd FRd LFd RBd BRu)(FDI UBr BUl DFr)(LUB RDb)(LUF LDb URf)(LDf DRf URb) 4s 8s 4s 2s 3s 3s.

$[[FB^2, L'R], bl^2r^2ud']$ (26 moves): (FUl UBl LDf DF1 LBd BDI DRf)(FUr

UBr ULb RUb DRb)(FLu RFu BRu)(FLd BRd)(FRd LUf URf)(FDr BLu
Dbr DLb) 7s 5s 3s 2s 3s 4s.

[[FB, RU^2], f^2b^2lrud'] (28 moves): (FUl BLu BUr)(FUr BLd FDI LDb FRd
DRb)(FLu URf BDr BUl LUf BRu)(FRu DRf LDf)(FLd URb LUb
BRd)(FDr BDI) 3s 6s 6s 3s 4s 2s.

[[$UD', L'R'F'$], $l^2r'ud$] (28 moves): (FUl BDI)(FUr UBr DLf LUf BUl)(FLu
RFu LBU)(FLd LBd BRd DRf RFd RUf)(FDI BDr DFr ULb LDb)(BRu
RUb DRb) 2s 5s 3s 6s 5s 3s.

[[FB', RU], $fb^2l^2r^2u'$] (26 moves): (FUl LUb BDI FLd)(FUr BDr LBU UBr
DFr BRu FLu)(FRu DRf RUf)(FRd LDb RBd RUb)(FDI BLd BUl
DRb)(LUf DLf) 4s 7s 3s 4s 4s 2s.

[[FB^2, RU'], $f^2b^2lrd^2$] (26 moves): (FUl DBr BRd URb DLb FLd)(FUr UBr
DLf BRu URf)(FLu FDI DFr)(FRu LUb BLu RDb)(FRd LUf Rdf
BLd)(BUl DBI) 6s 5s 3s 4s 4s 2s.

[[$FB^2, L'R$], $fb^2l^2r^2u'd$] (28 moves): (FUl BRd UBI DRf)(FUr BRu UBr
RUb DRb)(FLu LDb DFr BDr ULb)(FRu BLu)(FLd LDf DFI BDI
RUf)(FRd LUf BLd) 4s 5s 5s 2s 5s 3s.

[[$FB, L'R$], $fb'r^2u^2d^2$] (26 moves): (FUl FDr BDI BUr)(FUr BUl BDr
FDI)(FLu RFu BRu LBU)(FLd RFd BRd LBd)(LUb DLb LDf DRf RUf
URb)(LUf DRb) 4s 4s 4s 4s 6s 2s.

[[$FB, R'U'$], $fb'l'ru^2d^2$] (28 moves): (FUl FRu UBI DLb LUb)(FUr FRd
UBr DLf LUf)(FLu LFd)(FDI RBd RUb LBU)(FDr RBu RUf LBd)(BDr
Rdf DBI DRb) 5s 5s 2s 4s 4s 4s.

[[FB', RU'], $fb^2l^2r^2$] (24 moves): (FUl BDI FLd)(FUr BDr FLu)(FRu DRf
RFd RUf ULf LDf LUb RDb RBu)(FDI BLd BUl)(FDr BLu BUr)(BRd
URb DLb) 3s 3s 9s 3s 3s 3s.

[[$FB, R'U'$], $fb^2l^2ru^2d'$] (28 moves): (FUl FRu URb)(FUr DRb BDr Rdf
FRd UBr DLf LUf)(FLu BLd FDI)(FLd RUf BRd LUb)(FDr RBu
UBI)(BLu BDI DLb) 3s 8s 3s 4s 3s 3s.

[[$LF'B', BR'$], $f'b^2lr^2u^2d^2$] (32 moves): (FUl DRf BRd RFd RUf FLd
LDf)(FUr FLu ULb)(FRu FDr URb)(FDI LUf DBI BLd BUl)(BUr BLu
DLb)(BRu BDr DRb) 7s 3s 3s 5s 3s 3s.

[[FB', RU'], $fb^2l^2r^2$] (24 moves): (FUl BDI FLd)(FUr BDr FLu)(FRu DRf
LUb URb RDb RBu)(FRd RBd URf LUf DLf LDf)(FDI BLd BUl)(FDr

BLu BUr) 3s 3s 6s 6s 3s 3s.

$[[B^2L'F^2, R^2U^2], f^2b'ld]$ (28 moves): (FUl UBl BDI DFl)(FUr UBr BDr DFr)(FLu ULb LBu)(FRu RUf BRd RFd FLd DRf RBu)(BLd DLf LUf)(LDb DRb RUB) 4s 4s 3s 7s 3s 3s.

$[[FB^2, R'D'], fb'ru^2d^2]$ (26 moves): (FUl FLd FRu ULf)(FUr FLu FRd BLd BRu UBr)(FDl URf RDf)(FDr URb LUb)(BUl LBu RBd DBl DLf)(BDr LDb DRb) 4s 6s 3s 3s 5s 3s.

$[[U'L'R', UD'], f^2b^2lr^2d']$ (30 moves): (FUl FLd RBu URb DFl)(FUr LBu BDr)(FLu URf DLf)(FRu BDI DRf LBd UBl)(FRd DFr LDb ULb DRb)(BUr BRd ULf) 5s 3s 3s 5s 5s 3s.

$[[FB^2, RD], fb'lr'u'd]$ (28 moves): (FUl DFl DLb)(FUr DFr DLf)(FLu BUl RBd DRb)(FRu BDI LUb RFd DBr ULf)(FLd BUr RBu DRf)(BLu RUf LBd URb) 3s 3s 4s 6s 4s 4s.

$[[FB, L'R], bl^2r'u]$ (24 moves): (FUl UBl DFl DBr BDI)(FUr UBr DFr)(FLu RFu BRu LBu)(FLd RFd BRd LBd)(LUb LDb URb DRf RDb)(LUf LDb Urf) 5s 3s 4s 4s 5s 3s.

$[[FB, L'R], bl^2r'ud^2]$ (26 moves): (FUl UBl BUr FDr)(FUr FDI BDr DBl)(FLu RFu BRu LBu)(FLd LBd BRd RFd)(LUb LDb URb DRf RDb)(LUf LDb Urf) 4s 4s 4s 4s 5s 3s.

$[[FR^2, U^2D^2], br^2u^2d^2]$ (24 moves): (FUl BLu BDI FRu)(FUr BDr FRd BLd)(FLu FDI BRu BUl)(FLd BRd FDr BUr)(LUb URb RDb DLb)(LUf Urf RDf DLf) 4s 4s 4s 4s 4s 4s.

24 edge pieces, 8 cycles

$[[LR'F, U'D'], f^2b'ud^2]$ (28 moves): (FUl FLd)(FUr FDI)(FLu LBu)(FRu RBu)(FRd BLd)(FDr BRd)(BUr BDI)(BUl RDf LUf BDr ULb DLf Urf LDb DRb RUB) 2s 2s 2s 2s 2s 2s 2s 10s.

$[[FR^2, D^2B^2], fblru^2d']$ (28 moves): (FUl BUr)(FUr BRu BUl RFu LFd FLu DFr DBl BLd)(FRd BDr)(FDl LBu RBd)(LUb RUf)(LUf RDf)(LDb RUB)(LDb RDf) 2s 9s 2s 3s 2s 2s 2s 2s.

$[[FB, LR], lr^2u^2d^2]$ (24 moves): (FUl FDr DFl UFr BDI BUr UBl DBr)(FLu BRu)(FRu BLu)(FLd BRd)(FRd BLd)(LUb URb LDb DRf)(LUf LDb)(RUf RDb) 8s 2s 2s 2s 2s 4s 2s 2s.

$[[FR^2, D^2B^2], fblr^2u^2d^2]$ (28 moves): (FUl BRd DFl RFd BUr BLu

$LBd)(FU_r BR_u)(FL_u BDr)(FR_u FDr BDI FLd UBI)(LU_b RUf)(LUf$
 $RDf)(LD_b RU_b)(LDf RD_b) 7s 2s 2s 5s 2s 2s 2s 2s.$

$[[FB, L'R], b^2lr'u^2]$ (24 moves): $(FU_l DBr)(FU_r UBr BU_l DBI FDI$
 $DfR)(FL_u BR_u)(FR_u BL_u)(FLd BRd)(FRd BLd)(LU_b DRf LDf DL_b RUf$
 $ULf)(RU_b DR_b) 2s 6s 2s 2s 2s 2s 6s 2s.$

$[[FR^2, B^2D^2], fblr^2u^2d']$ (28 moves): $(FU_l BDI)(FU_r BR_u BU_l FRd FDI$
 $RF_u UBr BLd)(FL_u BDr LFd)(FDr BL_u BRd)(LU_b RUf)(LUf RDf)(LD_b$
 $RU_b)(LDf RD_b) 2s 8s 3s 3s 2s 2s 2s 2s.$

$[[LR'B, U^2D'], b^2l'ru^2]$ (28 moves): $(FU_l FLd)(FU_r BR_u FL_u)(FR_u$
 $BL_u)(FRd URf)(FDI DBI BU_l RDf)(FDr LBd DBr ULf BU_r LU_b$
 $RD_b)(BRd LDf)(LD_b RU_b) 2s 3s 2s 2s 4s 7s 2s 2s.$

$[[FBR', U^2], f^2b^2lr^2ud']$ (28 moves): $(FU_l BU_r)(FU_r DfR BU_l DR_b$
 $DLf)(FL_u BR_u)(FR_u BL_u)(FLd BRd)(FRd BLd)(FDI RDf LD_b)(BDr URf$
 $UL_b DBI RU_b LUf) 2s 5s 2s 2s 2s 2s 3s 6s.$

$[[FB, LR], b^2lr'u^2d^2]$ (26 moves): $(FU_l DBr)(FU_r DBI)(FL_u BLd FRd$
 $BR_u)(FR_u BL_u FLd BRd)(FDI DfR)(BU_r UBI)(LU_b DL_b)(LUf URf RU_b$
 $DLf RDf DR_b) 2s 2s 4s 4s 2s 2s 2s 6s.$

$[[L^2R^2F^2, BU^2], b^2ru^2d']$ (28 moves): $(FU_l BU_r RB_u BL_u LF_u)(FU_r BU_l$
 $DfR BDr)(FR_u DF_l)(FLd BDI RFd BRd LBd)(LU_b RD_b)(LUf RDf)(LD_b$
 $RU_b)(LDf RUf) 5s 4s 2s 5s 2s 2s 2s 2s.$

$[[FB'D, LR], l^2r'ud']$ (28 moves): $(FU_l LDf)(FU_r LD_b DfR)(FL_u RF_u LUf$
 $BLd LFd FRd LB_u)(FDI BU_l)(BU_r DBr DRf)(BR_u RBd RU_b)(BDI$
 $RD_b)(LU_b RUf) 2s 3s 7s 2s 3s 3s 2s 2s.$

$[[D^2B^2U^2, FR^2], b^2lrd]$ (28 moves): $(FU_l LF_u BL_u)(FU_r DfR BDr RF_u DBI$
 $BR_u)(FLd LBd BRd BU_r)(FRd FDI BU_l)(LU_b RD_b)(LUf RDf)(LD_b$
 $RU_b)(LDf RUf) 3s 6s 4s 3s 2s 2s 2s 2s.$

$[[FBR', U^2], f^2b^2lr'ud']$ (28 moves): $(FU_l BDI UR_b ULf BU_r)(FU_r BDr URf$
 $UL_b BU_l)(FL_u BR_u)(FR_u BL_u)(FLd BRd)(FRd BLd)(FDI RDf LD_b)(FDr$
 $RD_b LDf) 5s 5s 2s 2s 2s 2s 3s 3s.$

$[[R^2D'L^2, D'B^2], f^2l^2r'd^2]$ (28 moves): $(FU_l RD_b BDI LU_b)(FU_r BDr$
 $DfR)(FL_u BR_u)(FR_u BL_u)(FLd BRd)(FRd BLd)(FDI RU_b BU_l LD_b)(BU_r$
 $ULf DRf RUf LDf) 4s 3s 2s 2s 2s 2s 4s 5s.$

$[[FB, LR], lru^2d^2]$ (24 moves): $(FU_l UFr BDI DBr)(FL_u BR_u)(FR_u$
 $BL_u)(FLd BRd)(FRd BLd)(FDI UBr BU_l DfR)(LU_b UR_b LDf DRf)(LUf$

DRb LDb URf) 4s 2s 2s 2s 2s 4s 4s 4s.

[[$U'D'B', LR'$], $f'b'u^2d$] (28 moves): (FUl UBl BRd)(FUr FLu BRu RFu
LBu UBr)(FLd LBd RFd)(FDl BDr)(FDr URb LUb)(BDl DLb RDb)(LUf
DLf)(RUf DRf) 3s 6s 3s 2s 3s 3s 2s 2s.

[[$L'B'R, U'D^2$], $b^2l'u^2d'$] (28 moves): (FUl RDb LUb)(FUr UBr)(FLu DLf
BRu)(FRu BLu)(FLd RFd LBd DRf)(FDl LUf DBl BUI DFr)(BRd DBr
RUf)(LDb RUB) 3s 2s 3s 2s 4s 5s 3s 2s.

[[FB, LR], lru^2d'] (24 moves): (FUl UFr DBr)(FLu BRu)(FRu BLu)(FLd
RFd BRd LBd)(FDl UBr BUI)(FDr BDI)(LUb URb LDf DRf)(LUf DRb
LDb URf) 3s 2s 2s 4s 3s 2s 4s 4s.

[[FB, LR], $blr'u^2d'$] (26 moves): (FUl UFr DBr)(FLu RFu LBu RBd
BRu)(FLd RFd LBd)(FDl UBr BUI)(FDr BDI)(LUb RDb)(LUf LDb
URf)(LDf DRf URb) 3s 5s 3s 3s 2s 2s 3s 3s.

[[FB, LR], $bl'r'u$] (24 moves): (FUl BDI UBl)(FUr UBr DFr)(FLu RFu
BRu LBu)(FLd RFd BRd LBd)(FDl BDr)(LUb RDb)(LUf LDb URf)(LDf
DRf URb) 3s 3s 4s 4s 2s 2s 3s 3s.

[[$R^2D^2F^2, R'D'$], $f'b^2lr'u^2d'$] (32 moves): (FUl LUb LFu)(FUr RDf
LFd)(FRu DBr URb)(FRd DBl BLd UBr)(FDl RBd LUf)(FDr BLu
DLb)(BUI BRu DRb)(LDf RUf) 3s 3s 3s 4s 3s 3s 3s 2s.

[[FB, R], $f^2b^2lru^2d^2$] (24 moves): (FUl FRu DRf)(FUr FRd DRb)(FLu UBr
DLf)(FLd DFd DLb)(FDr LUb LBd)(BUI LUf LBu)(BRu URf BDr)(BRd
URb BDI) 3s 3s 3s 3s 3s 3s 3s 3s.

24 edge pieces, 10 cycles

[[$U'D^2L, R^2F'$], $f^2b^2lr'ud$] (32 moves): (FUl LUb LBd UFr ULf FRu)(FLu
FDl)(FLd FDr)(FRd URf)(BUr DRf)(BUI DRb)(BRu LDb)(BLu
URb)(BRd LDf)(BDr DBl) 6s 2s 2s 2s 2s 2s 2s 2s 2s 2s.

[[$R'U'D', R^2F^2B^2$], fr^2u^2d'] (32 moves): (FUl BDI)(FUr BDr)(FLu BRu
LBu RFu LFd)(FRd RBd BLd)(FDl BUI)(FDr BUr)(LUb RDb)(LUf
RDf)(LDb RUB)(LDf RUf) 2s 2s 5s 3s 2s 2s 2s 2s 2s 2s.

[[FB, LR], $lr'u^2d^2$] (24 moves): (FUl DBr)(FUr DBl)(FLu BRu)(FRu
BLu)(FLd BRd)(FRd BLd)(FDl DFr)(BUr UBl)(LUb URb LDf DRf)(LUf
URf LDd DRb) 2s 2s 2s 2s 2s 2s 2s 2s 4s 4s.

[[$D'L'R, F'B'$], $f'bl^2r^2$] (28 moves): (FUl BDI)(FUr BDr)(FLu BLd)(FRu

BRd)(FLd BLu)(FRd BRu)(FDl DFr)(BUr LUb URb)(BUl LUf URf)(LDb
RDf DLf DRb) 2s 2s 2s 2s 2s 2s 2s 3s 3s 4s.

[[FB, LR], $blru'd'$] (26 moves): (FUl BUr)(FUr BDr)(FLu BRu RFu)(FLd
RFd LBd)(FDl BUl)(FDr Bdl)(BLu BRd)(LUb RDb)(LUf LDb URf)(Ldf
DRf URb) 2s 2s 3s 3s 2s 2s 2s 2s 3s 3s.

24 edge pieces, 12 cycles

[[FB, LR], $l^2r^2u^2d^2$] (24 moves): (FUl FDr)(FUr Fdl)(FLu BRu)(FRu
BLu)(FLd BRd)(FRd BLd)(BUr Bdl)(BUl BDr)(LUb Ldf)(LUf LDb)(RUf
RDb)(RUb Rdf) 2s 2s 2s 2s 2s 2s 2s 2s 2s 2s 2s.

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