

FIG. 1

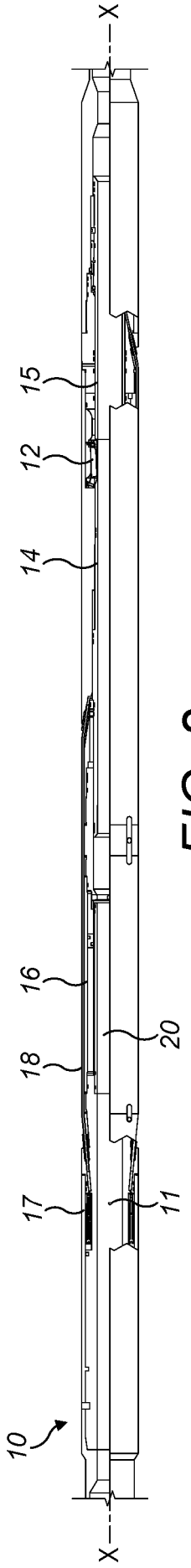


FIG. 2

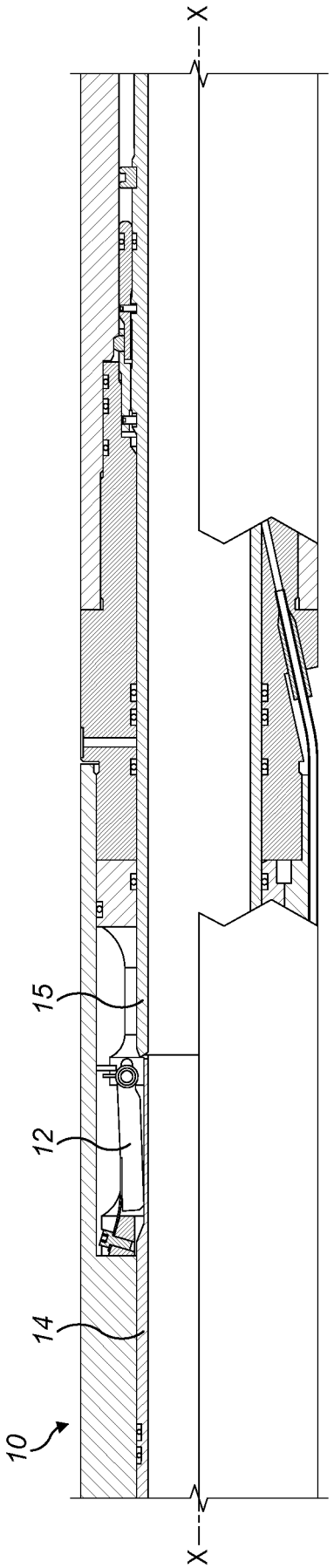


FIG. 3

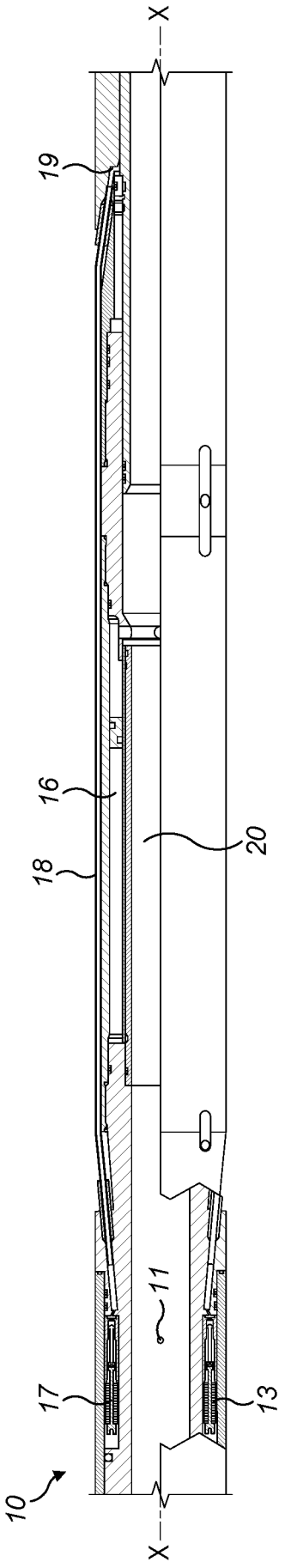


FIG. 4

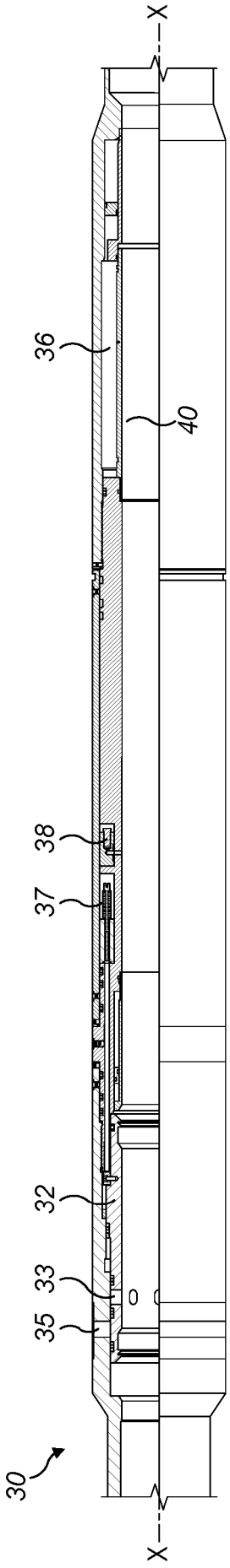


FIG. 5

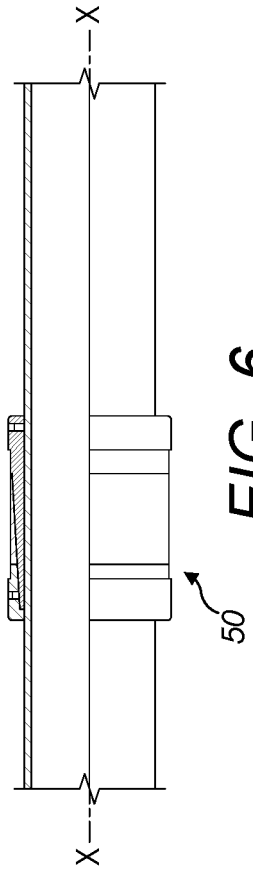


FIG. 6

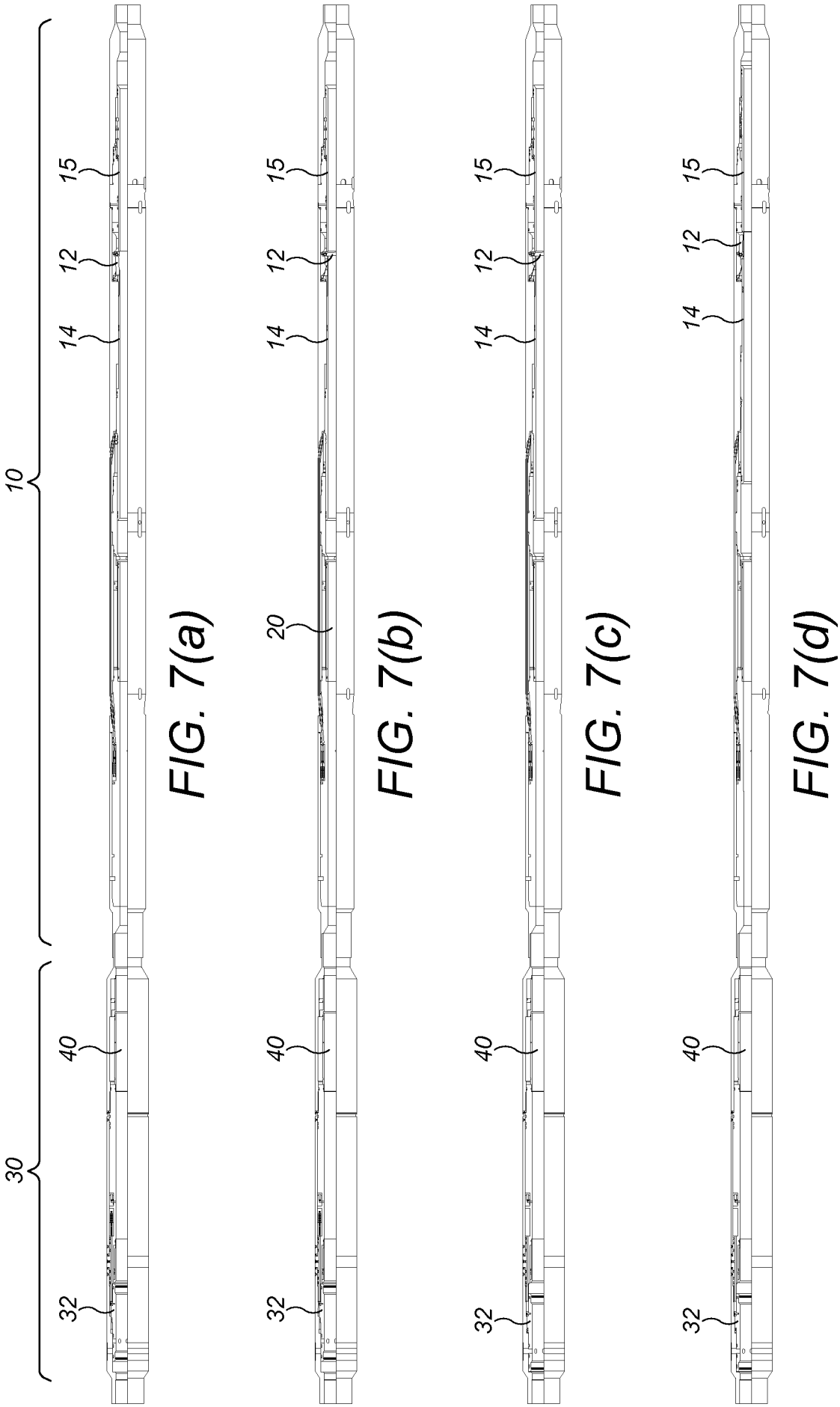


FIG. 7(a)

FIG. 7(b)

FIG. 7(c)

FIG. 7(d)

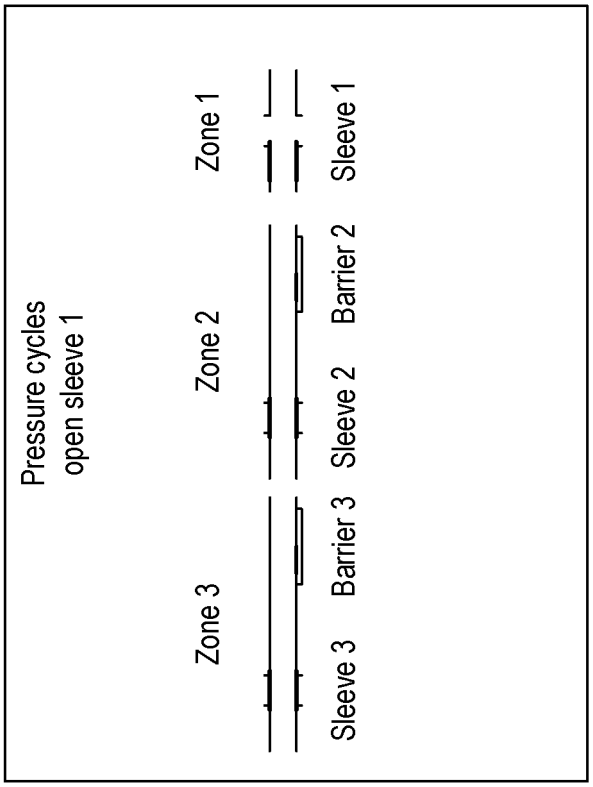

Pressure cycles
open sleeve 1
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 9

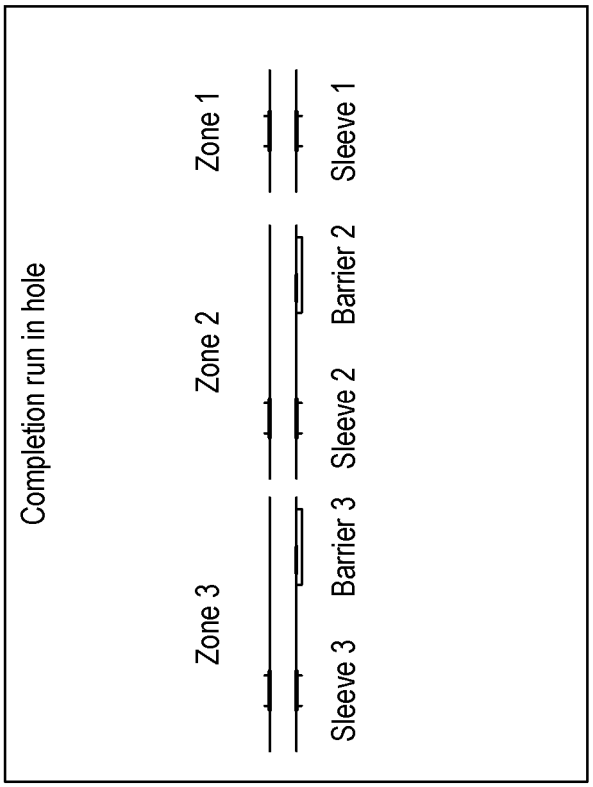

Completion run in hole
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 8

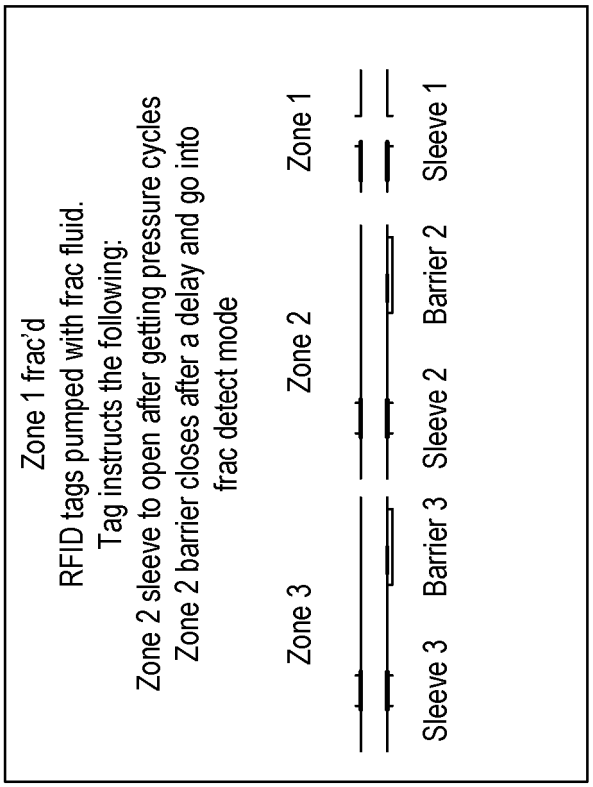

Zone 1 frac'd
RFID tags pumped with frac fluid.
Tag instructs the following:
Zone 2 sleeve to open after getting pressure cycles
Zone 2 barrier closes after a delay and go into
frac detect mode
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 10

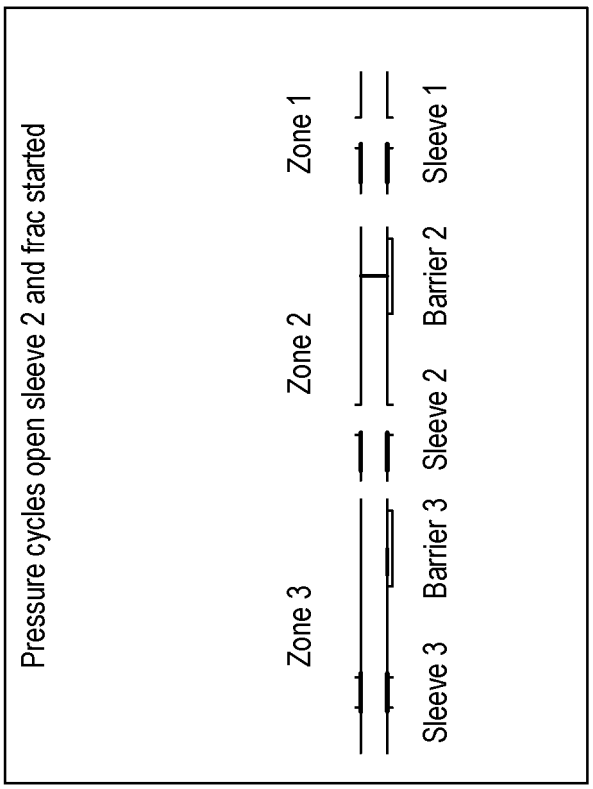

Pressure cycles open sleeve 2 and frac started
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 11

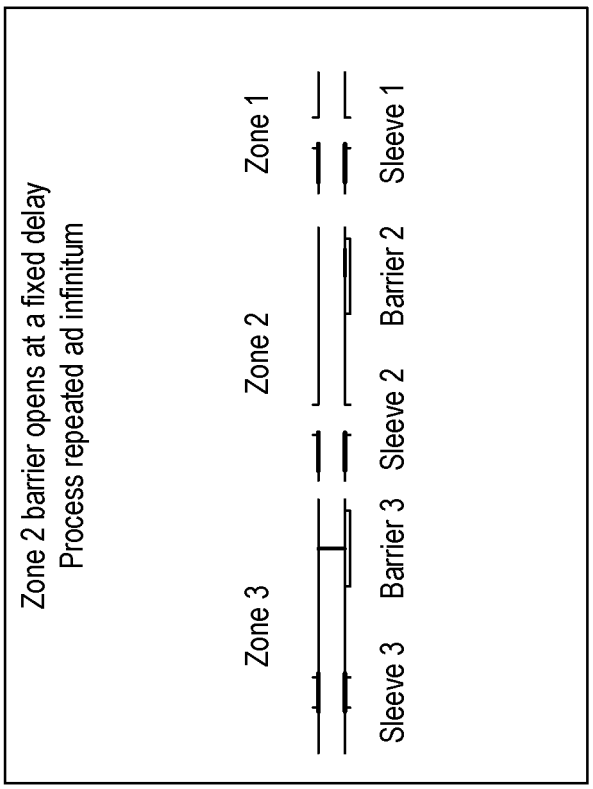

Zone 2 barrier opens at a fixed delay
Process repeated ad infinitum
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 13

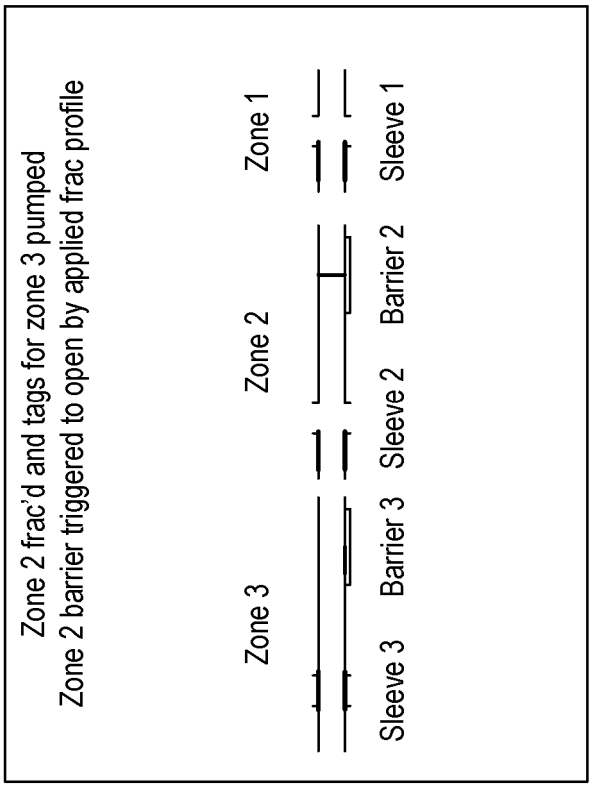

Zone 2 frac'd and tags for zone 3 pumped
Zone 2 barrier triggered to open by applied frac profile
Zone 3
Zone 2
Zone 1
Sleeve 3
Barrier 3
Sleeve 2
Barrier 2
Sleeve 1

FIG. 12

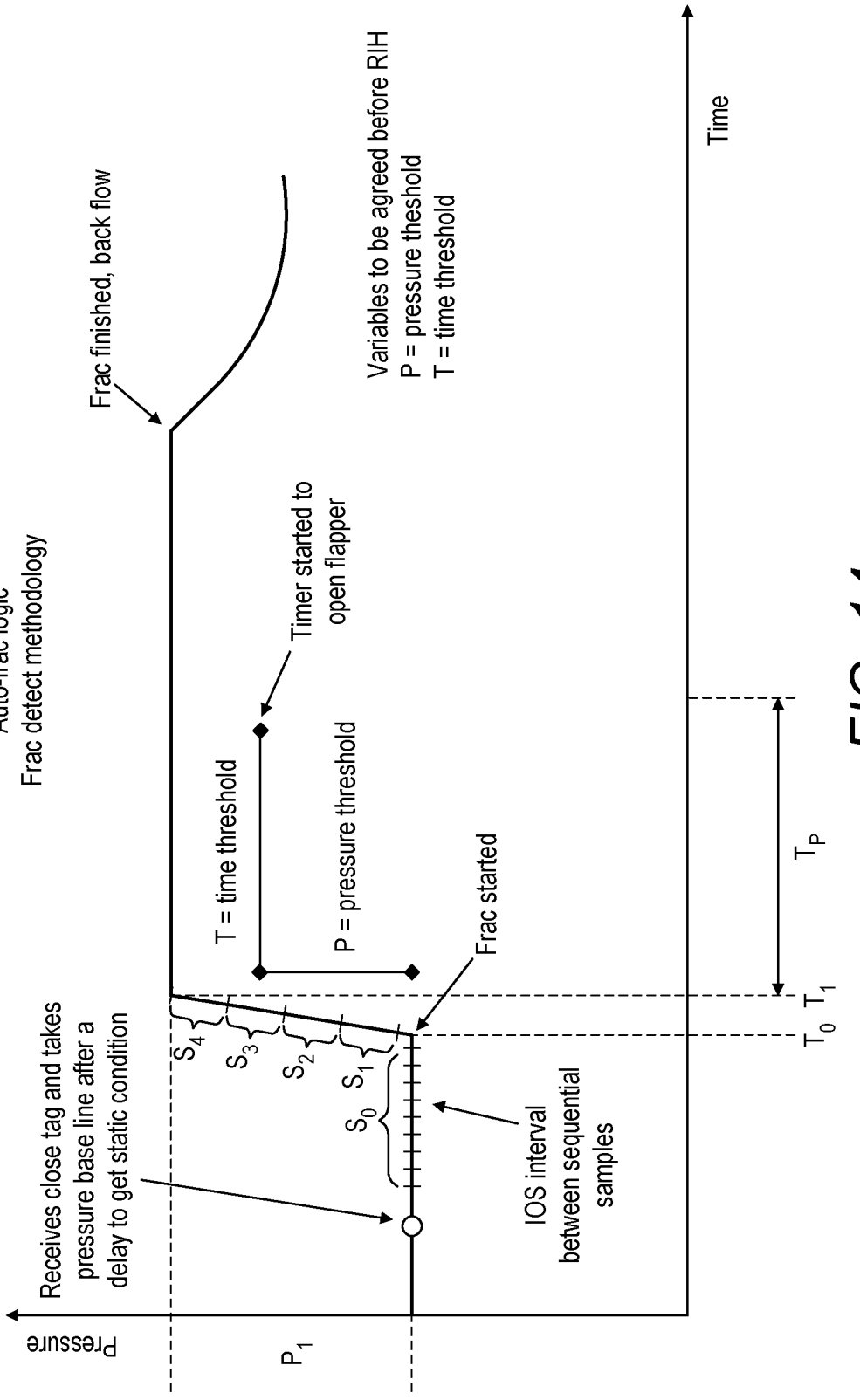

Auto-frac logic
Frac detect methodology
Frac finished, back flow
Variables to be agreed before RIH
P = pressure theshold
T = time threshold
Time
Timer started to
open flapper
T = time threshold
P = pressure threshold
Frac started
T_P
T_0 T_1
S_4
S_3
S_2
S_1
S_0
Receives close tag and takes
pressure base line after a
delay to get static condition
IOS interval
between sequential
samples
Pressure
P_1

FIG. 14

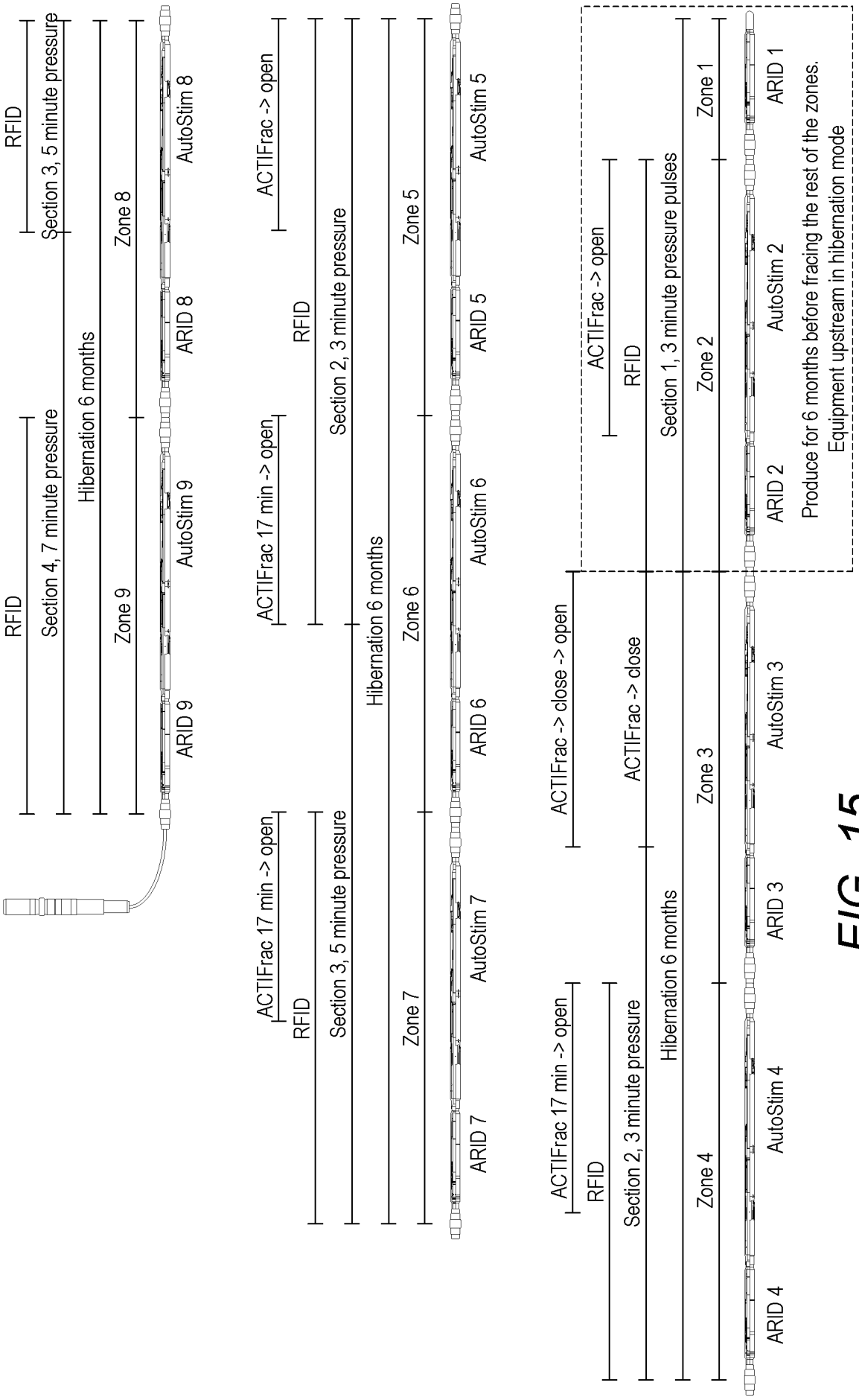

ACTIFrac -> open
RFID
Section 4, 7 minute pressure
Hibernation 6 months
Zone 9
Zone 8
ARID 9
AutoStim 9
ARID 8
AutoStim 8
ACTIFrac -> open
RFID
Section 3, 5 minute pressure
ACTIFrac 17 min -> open
RFID
Section 3, 5 minute pressure
Zone 7
Zone 6
ARID 7
AutoStim 7
ARID 6
AutoStim 6
ACTIFrac -> open
RFID
Section 2, 3 minute pressure
Hibernation 6 months
Zone 6
Zone 5
ARID 6
AutoStim 6
ARID 5
AutoStim 5
ACTIFrac 17 min -> open
RFID
Section 2, 3 minute pressure
Zone 4
Zone 3
ARID 4
AutoStim 4
ARID 3
AutoStim 3
ACTIFrac -> close -> open
ACTIFrac -> close
Hibernation 6 months
Zone 3
Zone 2
ARID 3
AutoStim 3
ARID 2
AutoStim 2
ACTIFrac -> open
RFID
Section 1, 3 minute pressure pulses
Zone 2
Zone 1
ARID 2
AutoStim 2
ARID 1
Produce for 6 months before fracing the rest of the zones.
Equipment upstream in hibernation mode

FIG. 15

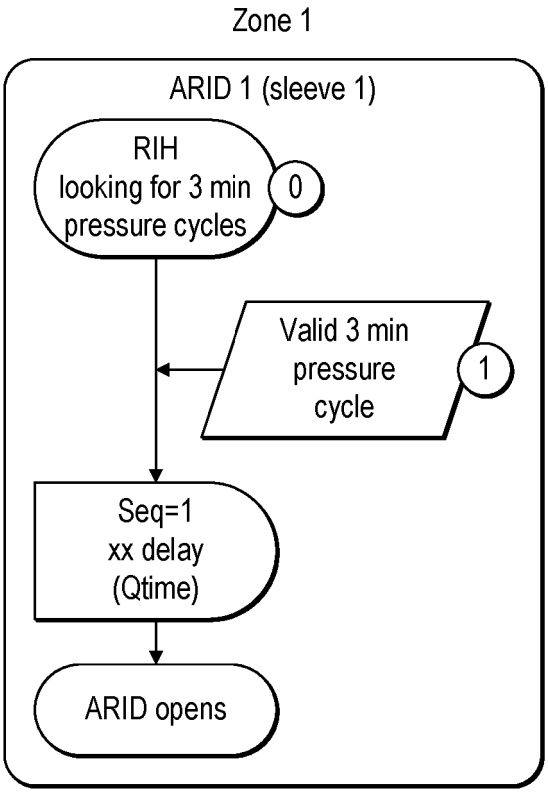

Zone 1
ARID 1 (sleeve 1)
RIH
looking for 3 min
pressure cycles
0
Valid 3 min
pressure
cycle
1
Seq=1
xx delay
(Qtime)
ARID opens

FIG. 16

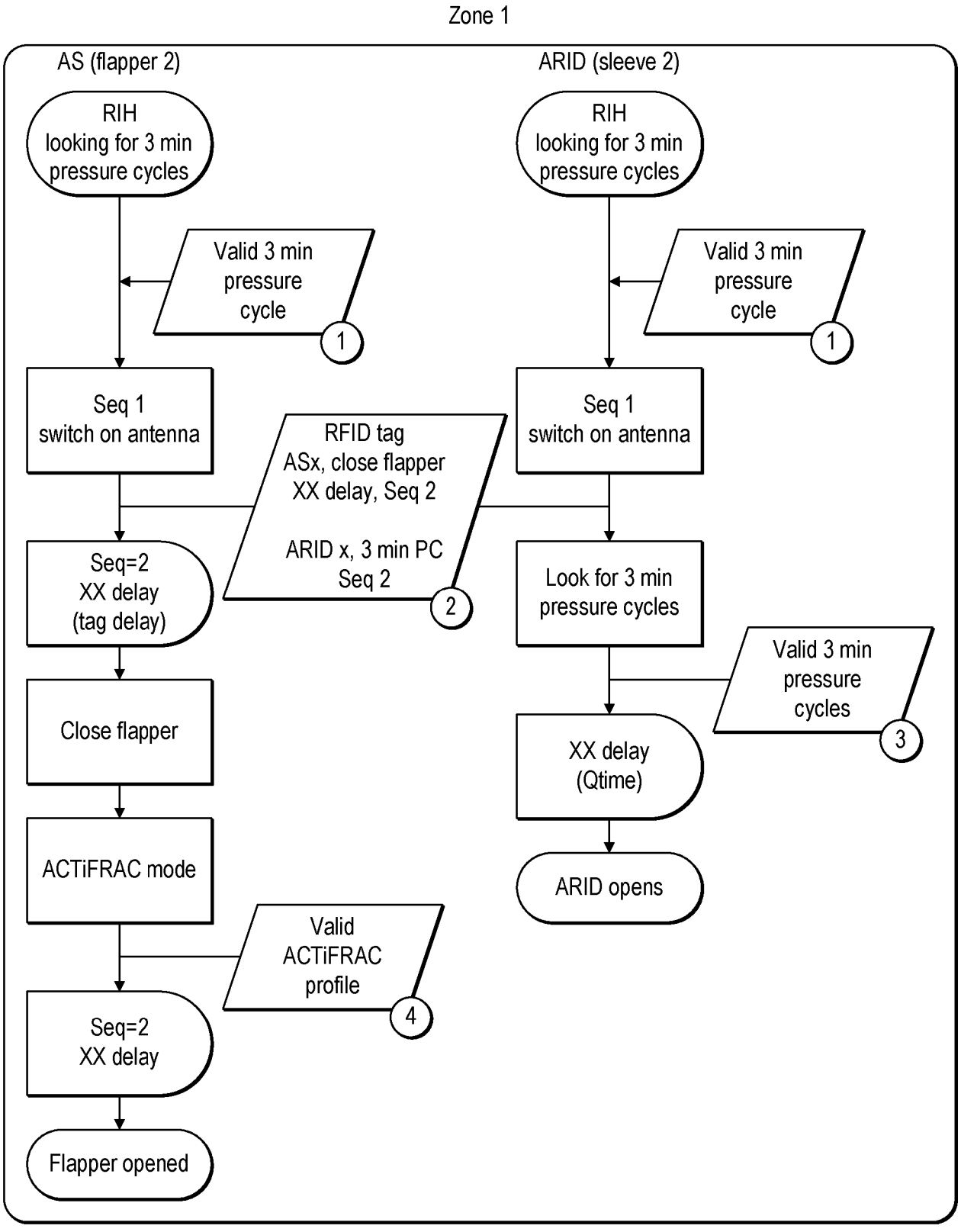

Zone 1
AS (flapper 2)
ARID (sleeve 2)
RIH looking for 3 min pressure cycles
RIH looking for 3 min pressure cycles
Valid 3 min pressure cycle
1
Valid 3 min pressure cycle
1
Seq 1 switch on antenna
Seq 1 switch on antenna
RFID tag ASx, close flapper XX delay, Seq 2
ARID x, 3 min PC Seq 2
2
Seq=2 XX delay (tag delay)
Look for 3 min pressure cycles
Valid 3 min pressure cycles
3
Close flapper
XX delay (Qtime)
ACTiFRAC mode
ARID opens
Valid ACTiFRAC profile
4
Seq=2 XX delay
Flapper opened

FIG. 17

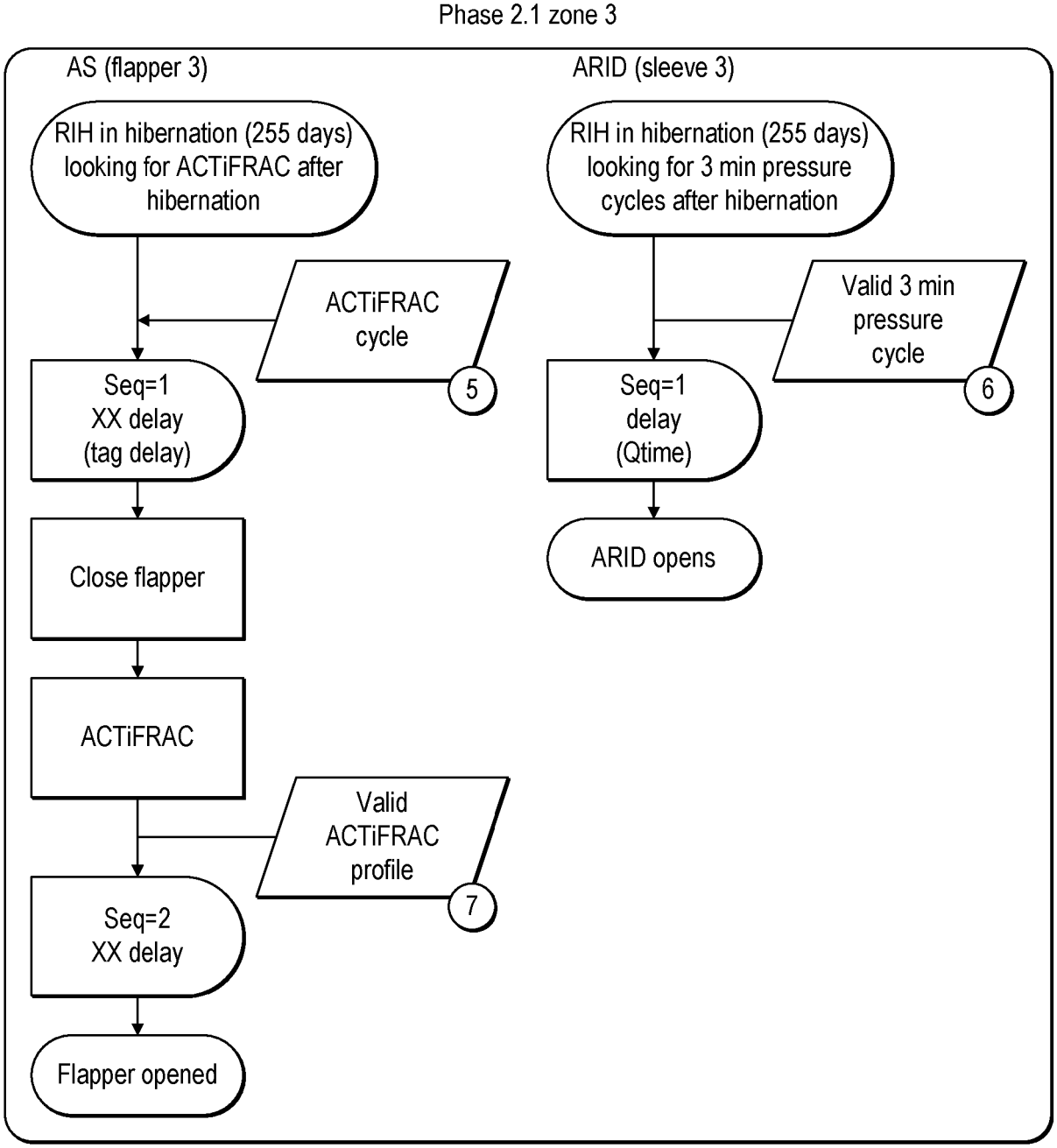

Phase 2.1 zone 3
AS (flapper 3)
ARID (sleeve 3)
RIH in hibernation (255 days) looking for ACTiFRAC after hibernation
RIH in hibernation (255 days) looking for 3 min pressure cycles after hibernation
ACTiFRAC cycle
5
Valid 3 min pressure cycle
6
Seq=1 XX delay (tag delay)
Seq=1 delay (Qtime)
Close flapper
ARID opens
ACTiFRAC
Valid ACTiFRAC profile
7
Seq=2 XX delay
Flapper opened

FIG. 18

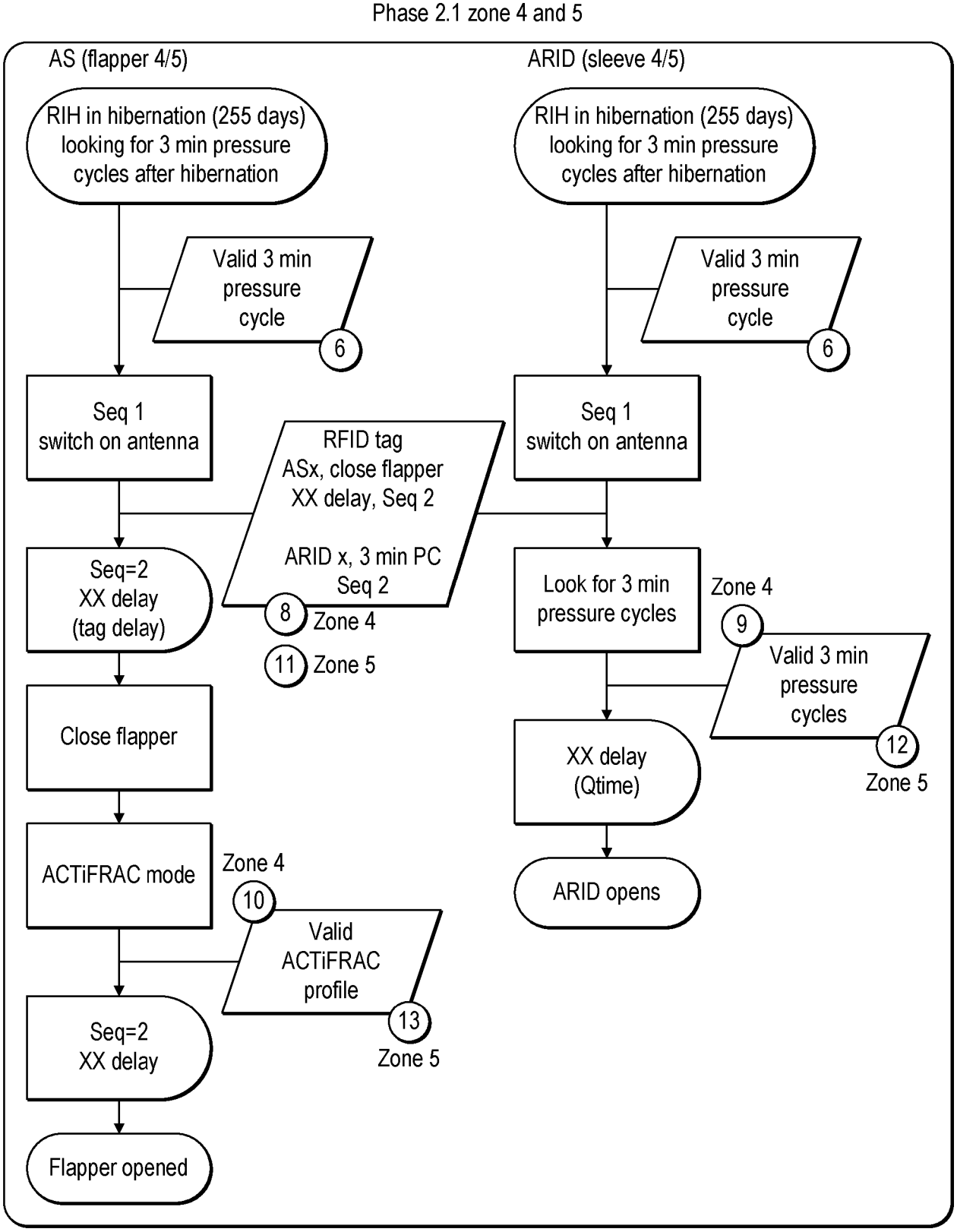

Phase 2.1 zone 4 and 5
AS (flapper 4/5)
ARID (sleeve 4/5)
RIH in hibernation (255 days) looking for 3 min pressure cycles after hibernation
RIH in hibernation (255 days) looking for 3 min pressure cycles after hibernation
Valid 3 min pressure cycle
6
Valid 3 min pressure cycle
6
Seq 1 switch on antenna
Seq 1 switch on antenna
RFID tag ASx, close flapper XX delay, Seq 2
ARID x, 3 min PC Seq 2
8
Zone 4
11
Zone 5
Seq=2 XX delay (tag delay)
Look for 3 min pressure cycles
Zone 4
9
Valid 3 min pressure cycles
12
Zone 5
Close flapper
XX delay (Qtime)
ACTiFRAC mode
Zone 4
10
Valid ACTiFRAC profile
13
Zone 5
ARID opens
Seq=2 XX delay
Flapper opened

FIG. 19

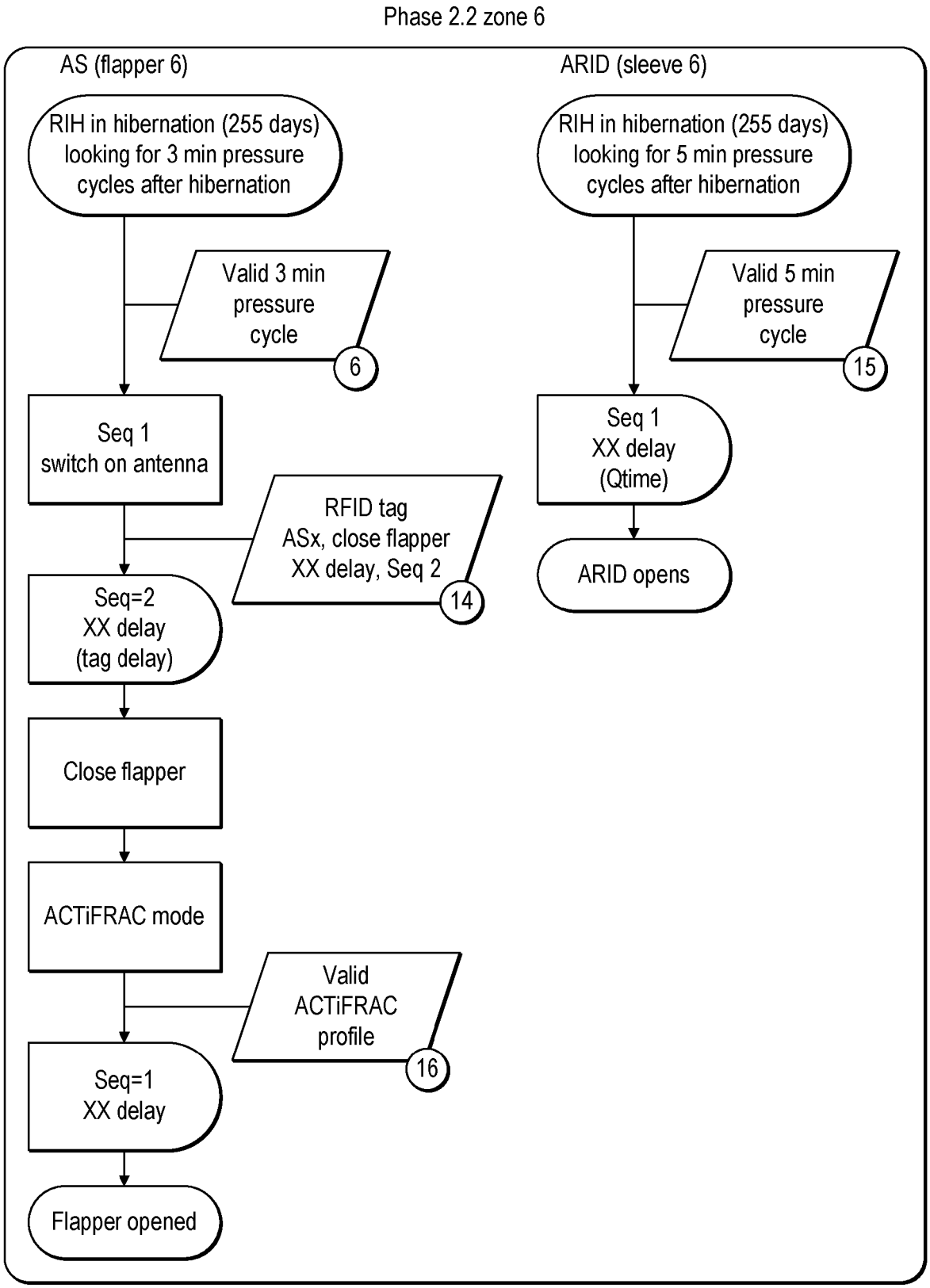

Phase 2.2 zone 6
AS (flapper 6)
ARID (sleeve 6)
RIH in hibernation (255 days) looking for 3 min pressure cycles after hibernation
RIH in hibernation (255 days) looking for 5 min pressure cycles after hibernation
Valid 3 min pressure cycle
6
Valid 5 min pressure cycle
15
Seq 1 switch on antenna
Seq 1 XX delay (Qtime)
RFID tag ASx, close flapper XX delay, Seq 2
14
ARID opens
Seq=2 XX delay (tag delay)
Close flapper
ACTiFRAC mode
Valid ACTiFRAC profile
16
Seq=1 XX delay
Flapper opened

FIG. 20

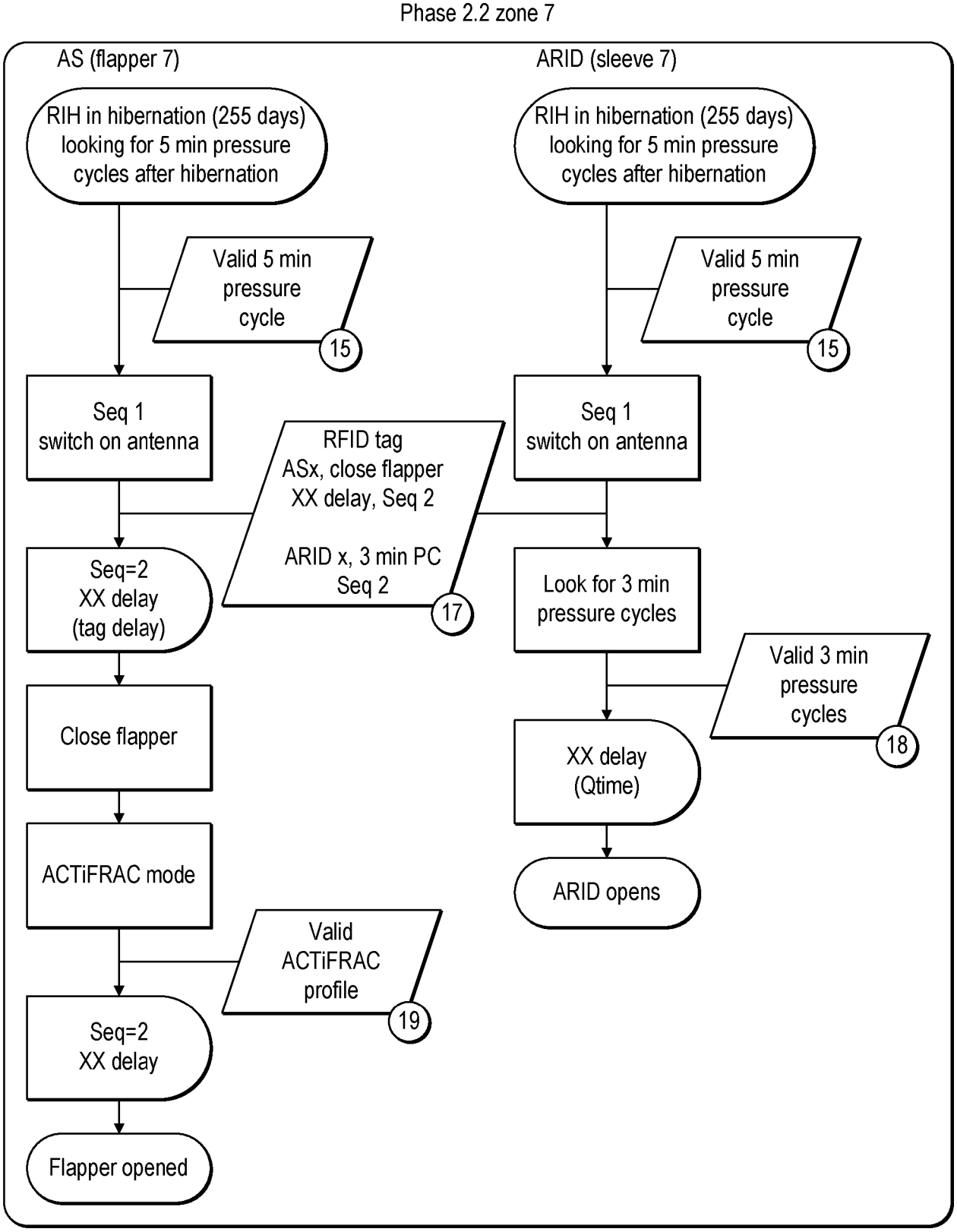

Phase 2.2 zone 7
AS (flapper 7)
ARID (sleeve 7)
RIH in hibernation (255 days) looking for 5 min pressure cycles after hibernation
RIH in hibernation (255 days) looking for 5 min pressure cycles after hibernation
Valid 5 min pressure cycle
15
Valid 5 min pressure cycle
15
Seq 1 switch on antenna
Seq 1 switch on antenna
RFID tag ASx, close flapper XX delay, Seq 2
ARID x, 3 min PC Seq 2
17
Seq=2 XX delay (tag delay)
Look for 3 min pressure cycles
Valid 3 min pressure cycles
18
Close flapper
XX delay (Qtime)
ACTiFRAC mode
ARID opens
Valid ACTiFRAC profile
19
Seq=2 XX delay
Flapper opened

FIG. 21

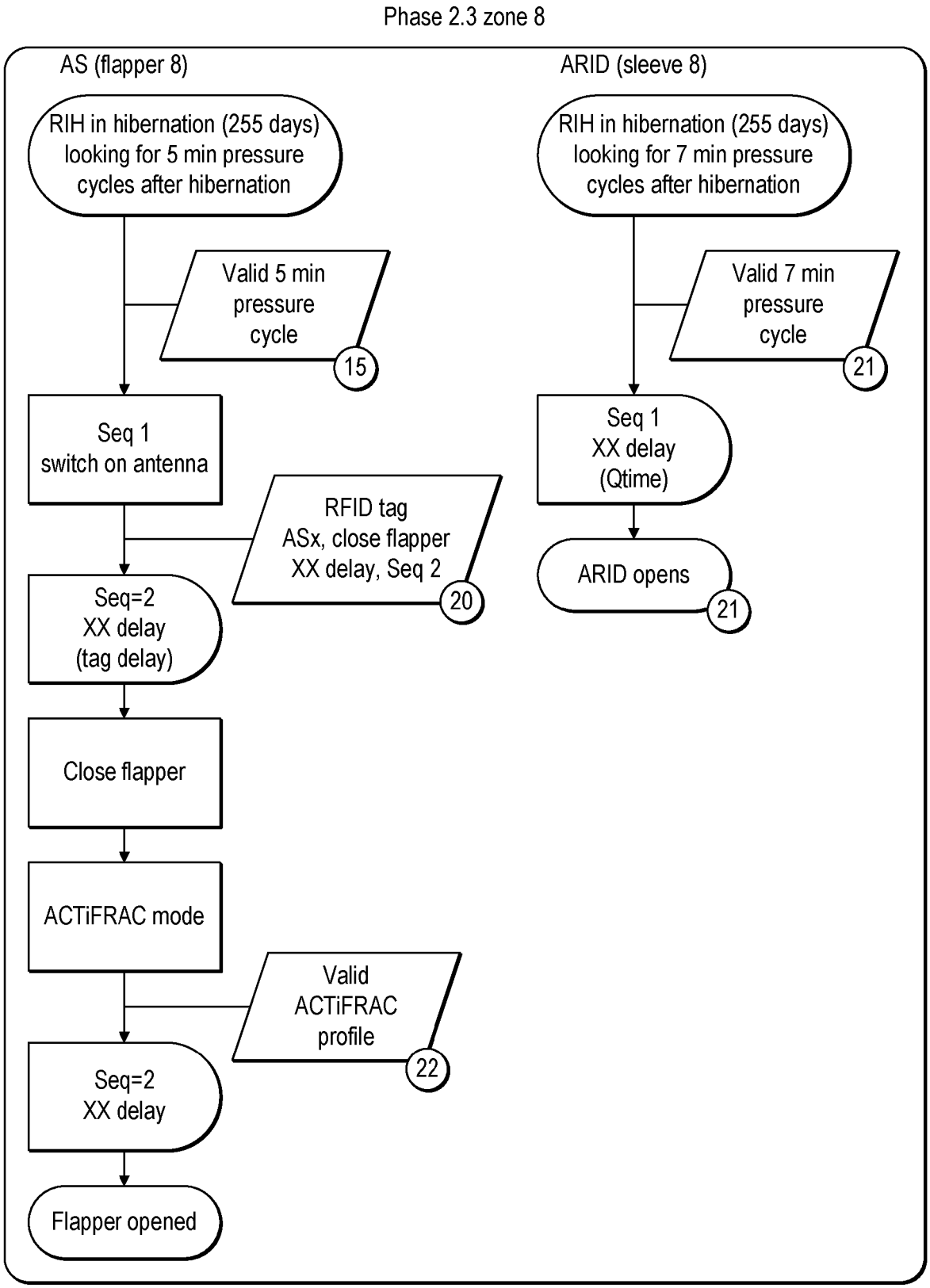

Phase 2.3 zone 8
AS (flapper 8)
ARID (sleeve 8)
RIH in hibernation (255 days) looking for 5 min pressure cycles after hibernation
RIH in hibernation (255 days) looking for 7 min pressure cycles after hibernation
Valid 5 min pressure cycle
15
Valid 7 min pressure cycle
21
Seq 1 switch on antenna
Seq 1 XX delay (Qtime)
RFID tag ASx, close flapper XX delay, Seq 2
20
ARID opens
21
Seq=2 XX delay (tag delay)
Close flapper
ACTiFRAC mode
Valid ACTiFRAC profile
22
Seq=2 XX delay
Flapper opened

FIG. 22

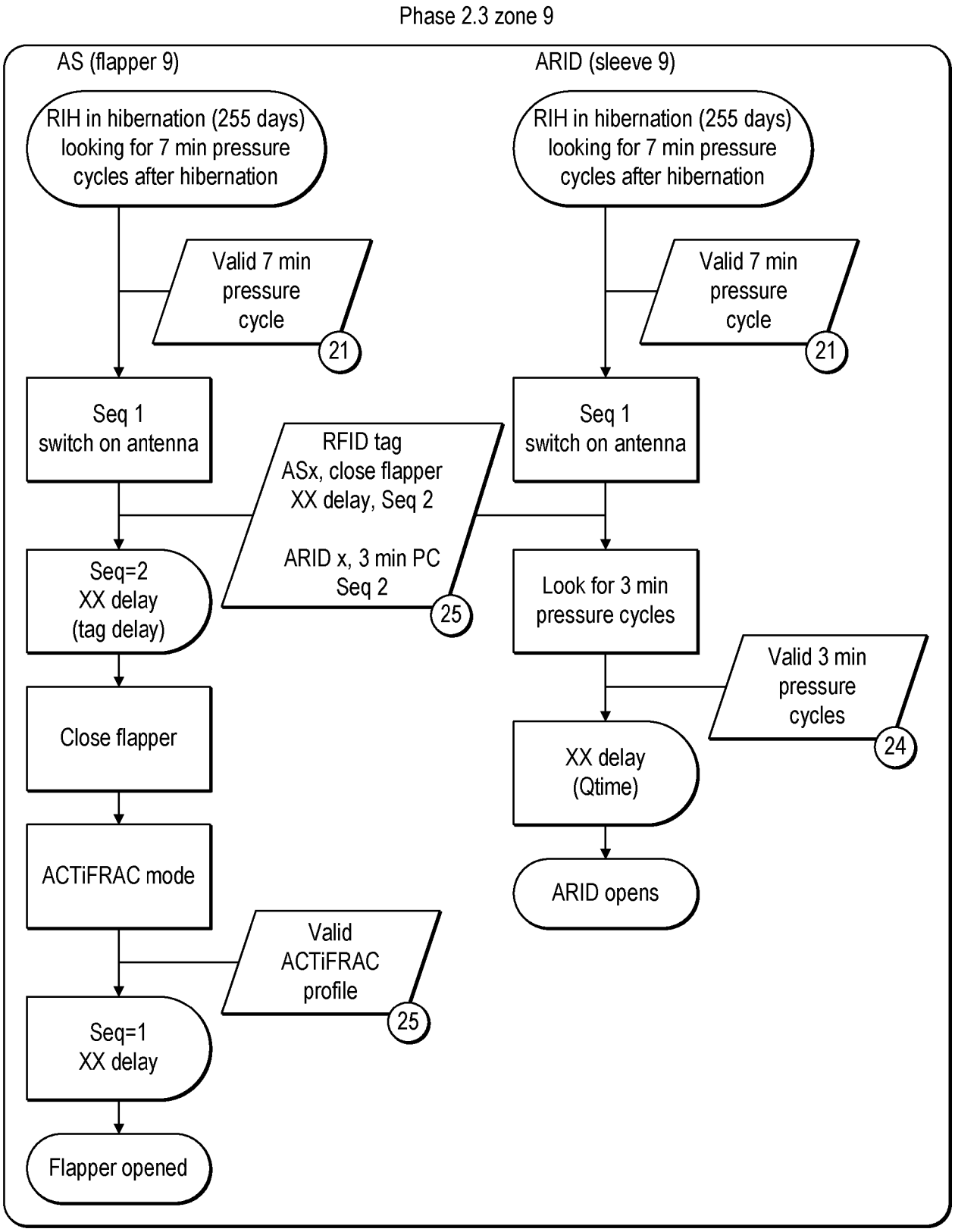

Phase 2.3 zone 9
AS (flapper 9)
ARID (sleeve 9)
RIH in hibernation (255 days) looking for 7 min pressure cycles after hibernation
RIH in hibernation (255 days) looking for 7 min pressure cycles after hibernation
Valid 7 min pressure cycle
21
Valid 7 min pressure cycle
21
Seq 1 switch on antenna
Seq 1 switch on antenna
RFID tag ASx, close flapper XX delay, Seq 2
ARID x, 3 min PC Seq 2
25
Seq=2 XX delay (tag delay)
Look for 3 min pressure cycles
Valid 3 min pressure cycles
24
Close flapper
XX delay (Qtime)
ACTiFRAC mode
ARID opens
Valid ACTiFRAC profile
25
Seq=1 XX delay
Flapper opened

FIG. 23

FIG. 24(a)

Key:
HIB-Hibernation
WPP-Waiting on pressure pulses
WRT-Waiting on RFID tags
Open (del)-Open on a delay

AS-ARID-Sleeve
AV-Autostim-Flapper

Step	Event	Action	AS9	AV9	AS8	AV8	AS7	AV7	AS6	AV6	AS5	AV5	AS4	AV4	AS3	AV3	AS2	AV2	AS1
			Sleeve 6	Flapper 6	Sleeve 5	Flapper 5	Sleeve 4	Flapper 4	Sleeve 3	Flapper 3	Sleeve 2	Flapper 2	Sleeve 1						
0	Running completion	-	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)
1	Open sleeve 1	3 MIN PP	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	WRT	WRT	Open
2	Pump tag	RT2	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	WPP (3 MIN)	Close/ WPP	Open
3	Open sleeve 2	3 MIN PP	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	Open	Close/ WPP	Open
4	Del opening flapper 2	ACTI FRAC	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	Open	Open (del)	Open
	Flow well 6 months	-	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	HIB	Open	Open (del)	Open
5	255 days	-	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (ACTI)	Open	Open (del)	Open
	Close flapper 3	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	WPP (3 MIN)	Close/ WPP	Open	Open (del)	Open
6	Activate phase 2.1 (open sleeve 1)	3 MIN PP	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WRT	WRT	WRT	WRT	Open	Close/ WPP	Open	Open (del)	Open
7	Del opening flapper 5	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WRT	WRT	WRT	WRT	Open	Open (del)	Open	Open (del)	Open
8	Pump tag	RT4	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WRT	WRT	WPP (3 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open

	Event	Action	Sleeve 9 AS9	Flapper 9 AV9	Sleeve 8 AS8	Flapper 8 AV8	Sleeve 7 AS7	Flapper 7 AV7	Sleeve 6 AS6	Flapper 6 AV6	Sleeve 5 AS5	Flapper 5 AV5	Sleeve 4 AS4	Flapper 4 AV4	AS3	AV3	AS2	AV2	AS1
9	Open sleeve 4	3 MIN PP	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WRT	WRT	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open
10	Del opening flapper 4	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WRT	WRT	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
11	Pump tag	RT5	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	WPP (3 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
12	Open sleeve 5	3 MIN PP	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
13	Del opening flapper 5	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WRT	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
14	Pump tag	RT6	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	WPP (5 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
15	Activate phase 2.2 (open sleeve 6)	5 MIN PP	WPP (7 MIN)	WPP (7 MIN)	WPP (5 MIN)	WRT	WRT	WRT	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
16	Del opening flapper 6	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (7 MIN)	WRT	WRT	WRT	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
17	Pump tag	RT7	WPP (7 MIN)	WPP (7 MIN)	WPP (7 MIN)	WRT	WPP (3 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open

FIG. 24(b)

	Event	Action	AS9	AV9	AS8	AV8	AS7	AV7	AS6	AV6	AS5	AV5	AS4	AV4	AS3	AV3	AS2	AV2	AS1
			Sleeve 9	Flapper 9	Sleeve 8	Flapper 8													
18	Open sleeve 7	3 MIN PP	WPP (7 MIN)	WPP (7 MIN)	WPP (7 MIN)	WRT	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
19	Del opening flapper 7	ACTI FRAC	WPP (7 MIN)	WPP (7 MIN)	WPP (7 MIN)	WRT	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
20	Pump tag	RT8	WPP (7 MIN)	WPP (7 MIN)	WPP (7 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
21	Activate phase 2.3 (open sleeve 8)	7 MIN PP	WRT	WRT	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
22	Del opening flapper 8	ACTI FRAC	WRT	WRT	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
23	Pump tag	RT9	WPP (3 MIN)	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
24	Open sleeve 9	3 MIN PP	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Close/ WPP	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open
25	Del opening flapper 9	ACTI FRAC	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open	Open (del)	Open

FIG. 24(c)

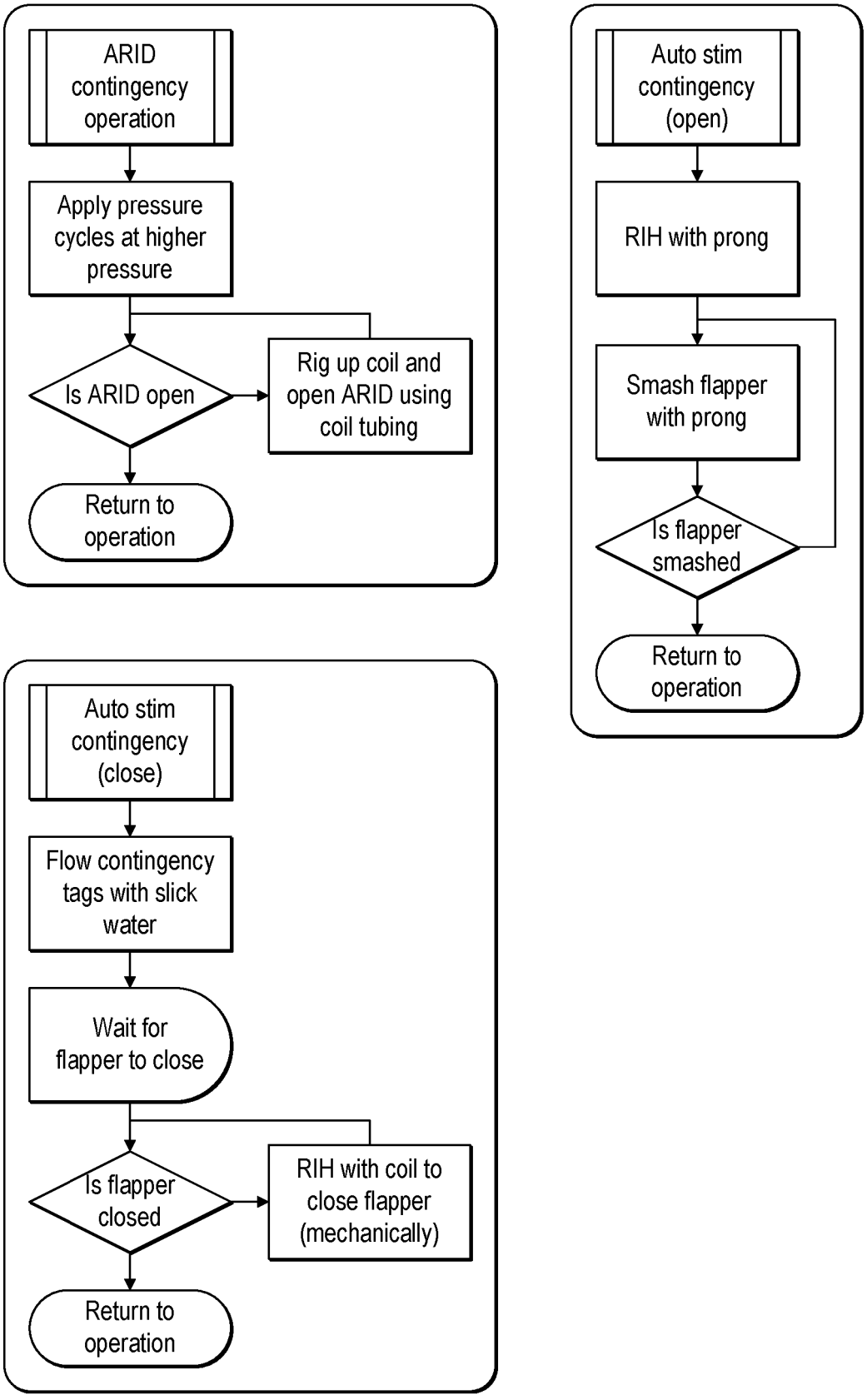

ARID contingency operation
Apply pressure cycles at higher pressure
Is ARID open
Rig up coil and open ARID using coil tubing
Return to operation
Auto stim contingency (open)
RIH with prong
Smash flapper with prong
Is flapper smashed
Return to operation
Auto stim contingency (close)
Flow contingency tags with slick water
Wait for flapper to close
Is flapper closed
RIH with coil to close flapper (mechanically)
Return to operation

FIG. 25

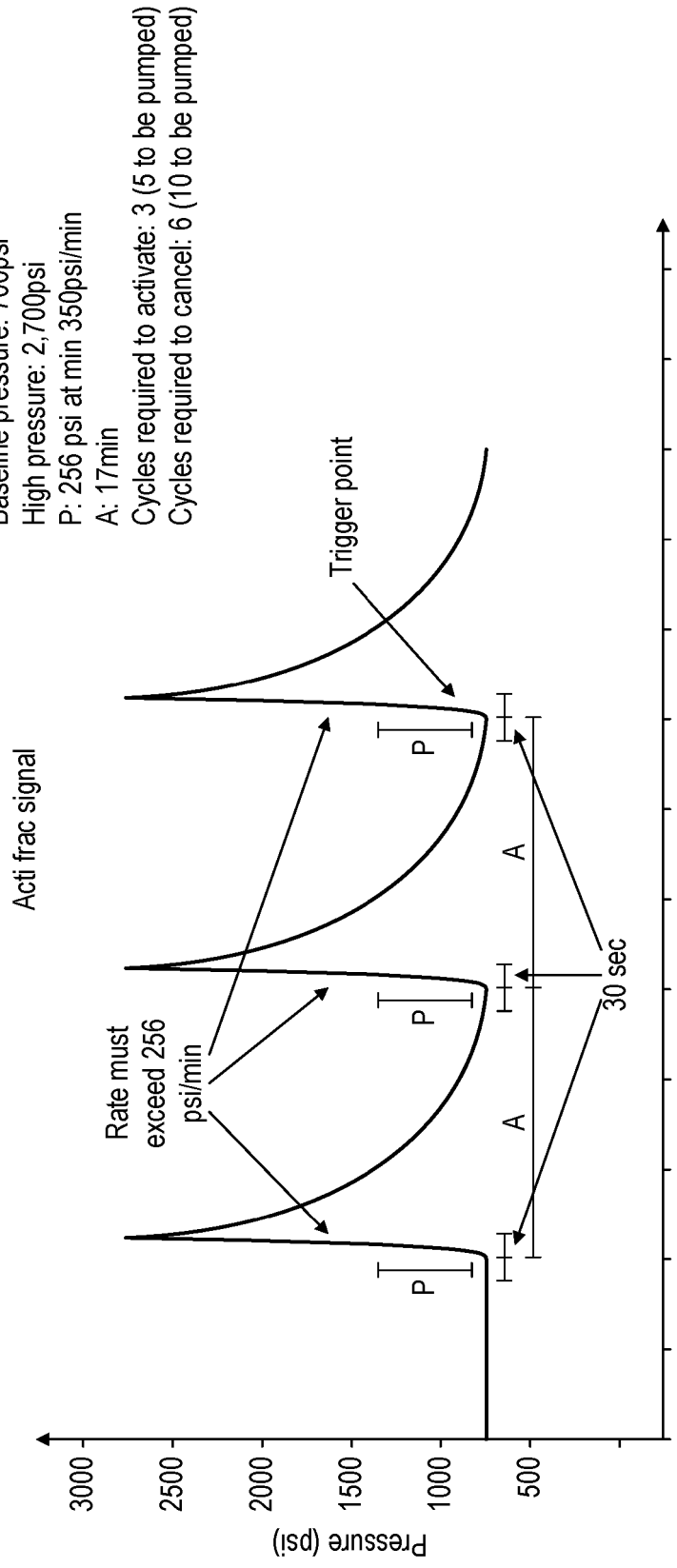

Baseline pressure: 700psi
High pressure: 2,700psi
P: 256 psi at min 350psi/min
A: 17min
Cycles required to activate: 3 (5 to be pumped)
Cycles required to cancel: 6 (10 to be pumped)
Acti frac signal
Trigger point
Rate must exceed 256 psi/min
P
A
30 sec
Time
Pressure (psi)
3000
2500
2000
1500
1000
500

FIG. 26

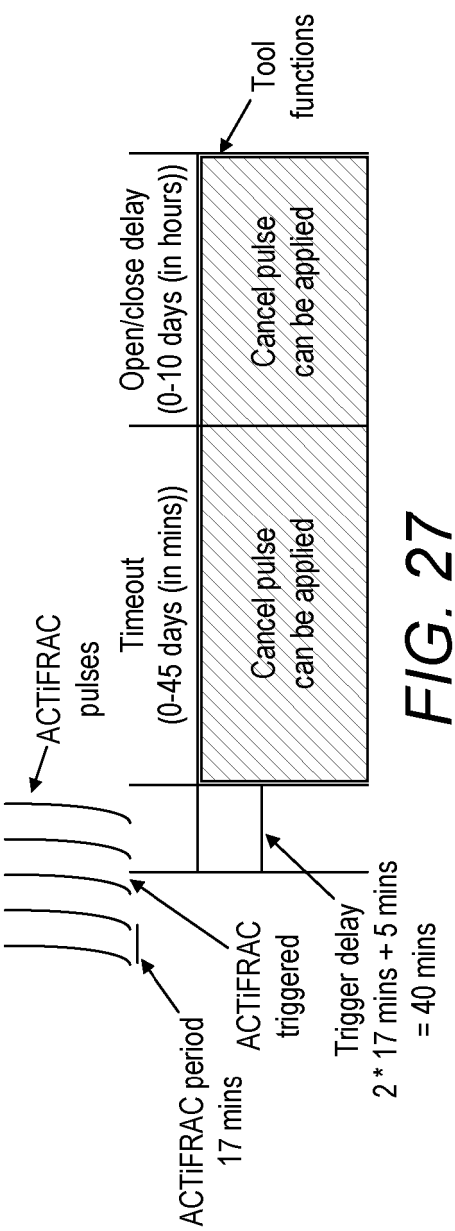

ACTiFRAC pulses
Timeout (0-45 days (in mins))
Open/close delay (0-10 days (in hours))
Tool functions
Cancel pulse can be applied
Cancel pulse can be applied
ACTiFRAC period 17 mins
ACTiFRAC triggered
Trigger delay 2 * 17 mins + 5 mins = 40 mins

FIG. 27

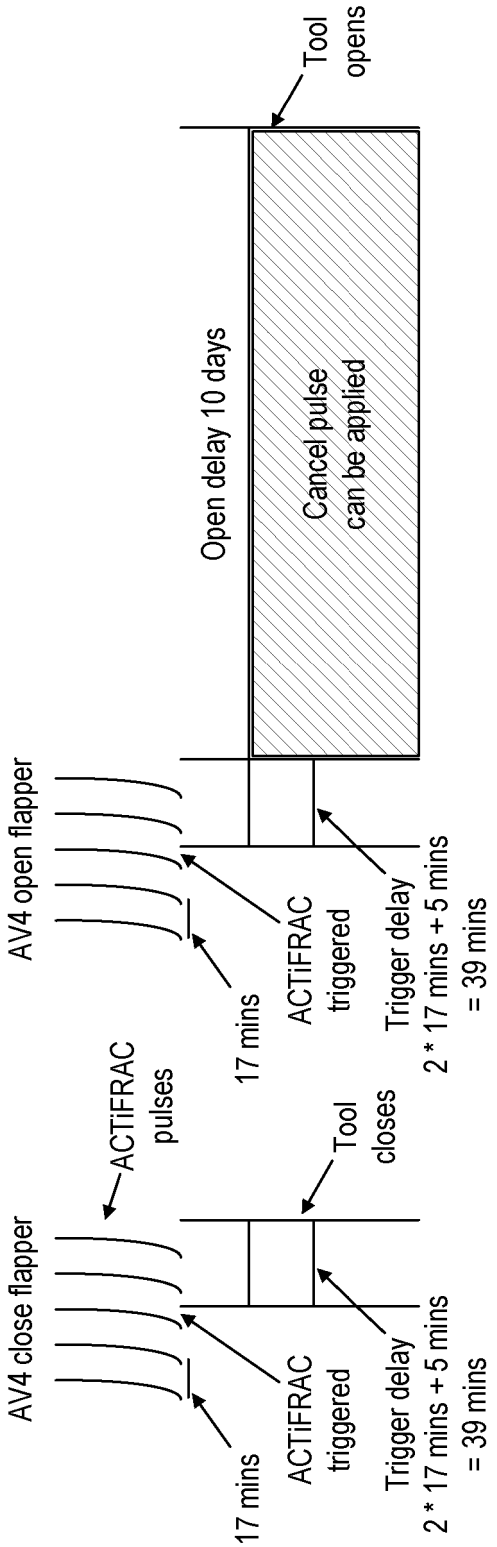

Tool opens
Open delay 10 days
Cancel pulse can be applied
AV4 open flapper
ACTiFRAC pulses
17 mins
ACTiFRAC triggered
Trigger delay 2 * 17 mins + 5 mins = 39 mins
AV4 close flapper
Tool closes
17 mins
ACTiFRAC triggered
Trigger delay 2 * 17 mins + 5 mins = 39 mins

FIG. 28

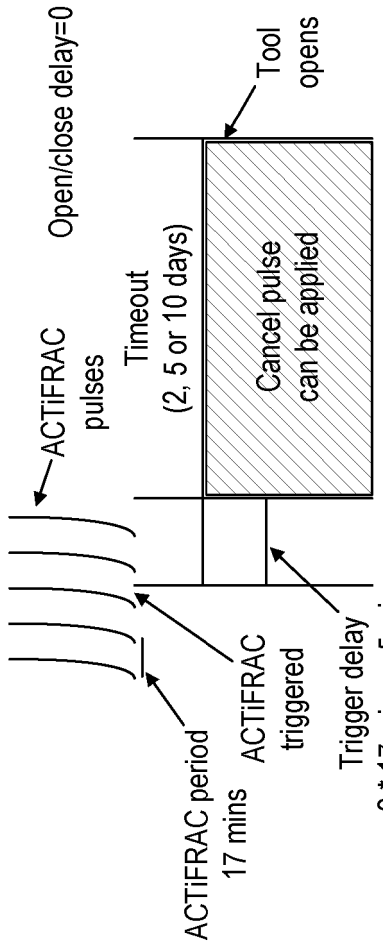

Open/close delay=0
Tool opens
ACTiFRAC pulses
Timeout (2, 5 or 10 days)
Cancel pulse can be applied
ACTiFRAC period 17 mins
ACTiFRAC triggered
Trigger delay 2 * 17 mins + 5 mins = 40 mins

FIG. 30

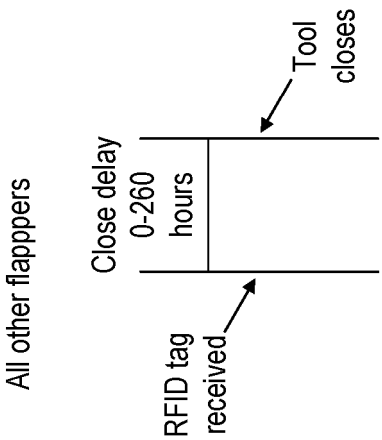

All other flapppers
Close delay 0-260 hours
Tool closes
RFID tag received

FIG. 29