
8:4

õ

ö

66

3

õ

398

422

ö

/

/

* / /

4

403

40303

3 42370303
4 42380;03
5 423:0303
6 423:
7 423:
8 423:
9 4234
: 422:0:04;
;
32 4232034047
33 42240:04;
34 42260:04:
35 42380903
36 422403204:
37 423203203
38 423905030

40304

4030403

3 8:4 423903203
4 66 423: 6
4: 4239 ; 3
5]4232_9
6]4233_57

7 57 423709035
8 6 423;0303
9 > * +@
]4235_325
:
;
32]4236_6:
]4237_384
]4235_59
42350;032
33
]4236_52 423605047
34
]4235_326
35]4237_39
36]4238_53
37 43
423504048
38 4234 4234 53
39 4234
4234
]4234_ ; :
3:
]4237_665
3;
]4237_39:
42]4227_374

43]4232_335
44
]4234_99
45
]4234_ ; :
46 *]4237_38;
+
47
]4235_326 4235033037
48]4237_385
49 4238 : 3
4: 7;3 423303403
4030404
3 5; 4227 5 47
4 3;;9 32 47
5 5;
4238 5 3
6
69 4237 8 3
7 *
62
8 > @]4235_92
9 > @]4226_64

: > @
]422;_6
; > *422:/4252
+@]422;_7
32
]4233_336
33
64 4237 3 3
34
4232 45:
35 4235 ; 8
36 *4235/4239 +]4235_445
37 *]4236_485
+
38]4229_87
4229 7 4;
39]4234_46
3:]4234_446
3;
]4235_454 4235 9 39
42
4237 32 35
43
]422:_8
44

]4229_385 422: 3 3

45



7 JL406/422;

8 JLIV38;/4226

9 4239

65

: JL885/4235

; 423808036

32 * + 4228 33

33 JLIV4;:/4229

34 ID3:43:/422;

35 ID3:7;9/4223

36 JL4247/4234

37 JL4264/4236

40306

3

4

5

6

7

8

9

5

40404

3

4

5

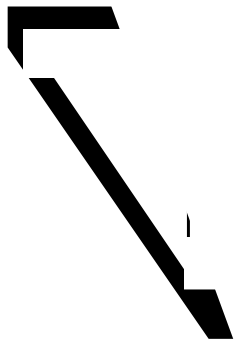
6

405

405/3

405/3

		405/3			405/3		
3	ö-ö	ö/ö	ö3ö	ö4ö	ö5ö		
4	öFö	öEö					
5							
6							



40

40704

JL832/4238

40706

ID3:43:/422;

308/4

M ô o l f

K ô

V ô

7222f P g ô

7 N? 4 M 302

?78o 4lN?4: o

7

4: o

8

522 o

)â 1 C^Pœ\$

		722		
	PQ ₄	46 :2		
		422		
		402	o ilo ⁵	FD3513799/4234
	J ₄ U	2023	o ilo ⁵	VL58/9;
	P J ₅	2024	o ilo ⁵	
	r J	8 ;	o ilN	* ID5:5:/4224+ KX
	EQF	Ö52		
	DQF ₇	Ö8		
		Ö205		
		Ö307		
		Ö307		
	r J	807 ô :07	o ilN	* IDIV36:6:/;5+
		Ö502		
		Ö672		
		Ö204		
		Ö472		
		Ö472		
		Ö42		
		Ö2024		
		Ö3222		
		Ö205		
		Ö37		
		Ö2027		
		82		
		72		

40904

3

* ID384;9/3; ;8+ 4

*FD351544/4238+ 3 5

4

ID3:7; ;/4223

*4235 58 +

ID3:7;9/4223

*4235 58 +

5

ID3456:/422: 4

ID34745/4233

		Ö302o ilo ⁵	*ID384;9/3;;8+ 4
	//	:2o ilo ⁵	*FD351544/4238+ 3
		602o ilo ⁵	*FD351544/4238+ 5
	Ngs *C+	82*C+	ID3456:/422: 4
		72*C+	
		92*C+	ID34745/4233
		77*C+	

422		G	325	ID52;7/4234
		UG	6:	
		YP	3:4	
		G	352	
		Y	377	
		YP	395	
		Y	387	
		G	327	
		PY	98	
		PY	:;	
		G	3;;	
		P	66	
		U	65	
		G	326	
		Y	33:	
		UG	;9	
		YP	35:	
		UG	37;	
		U	78	
		Y	64	
		UG	83	
		UG	3:7	
		U	:8	
		PY	39;	
		G	48	
		Y	377	
		P	:2	
		U	372	
		Y	42	
		PY	6:	
		PG	325	
	UG	363		
	U	332		

--	--	--	--

5

503

50303

3

ô

4

ô

7

50304

/

34;0;mo

503/3

42 o

7

9309mo

7:04mo

503/4

7

503/5

5843;079

522

: '

8;

72

3;

32

32

32

32

32

3;

587f

43

4239

34

4;

423; ;

503/6

42

423;

50404

	EJ ₆	E ₄ J ₈	E ₅ J :	kE ₆ J ₃₂	pE ₆ J ₃₂	kE ₇ J ₃₄	pE ₇ J ₃₄	pE ₈ J ₃₆	P ₄	EQ ₄
XIX ,	;508744	408;;6	207495	202;95	202;99	202588	20422	2028:7	305:84	30456 :

	*milo ⁵⁺		*OLI o ⁵⁺	*OLI o ⁵⁺
	20:24	20887	54085	5707;

505

50503

3

ID72473/4225

ö

ö



4

ô

63%

63%

U252

U252

I 329

I 329

I 329

I 329

9309mo

$\hat{\delta}$

Z576

Z576

Z574

Z574

440:mo

K 0 3

I 334

I 334



0F0 F Ô

5; 53)6;0;4\$

338 24)32062\$

5; 47)65036\$

5; 38440;;\$

338 23)50;9\$

5

5509

3504

4207

5; 347;055\$

337 75)2097\$

5; 343;052\$

337 66)52096\$

6

4;05

63

50605

3202ORc

806ORc

3

3

5			6832022	
6		'	560:2	
7			382;022	
8			579022	
9		'	:0:2	
:		'	202:	
;		o	4:9086	
32		o	8022 4022	

7

3

4

5		7549037
6	'	54089
7		4264057
8		5;403:
9	'	:042
:	'	2027
;	o	532077

U [1V7;44/4225

3

U [1V8692/4222

8

J Y2;

J Y6;

50607

	FP572 RP322 I FQ/2; [/3621\ J 8842		3
	FP722		3

RP322	
IFQ/37 [/3: 21 \ J 8842	
FP;22	
RP322	4
Sokp54 o lj Socz6222 o lj	
302	5
FP522	
RP322	3
R3?32ORc	
R4?807ORc	4

FP622	3
FP72	3
FP72	3
FP72	3
FP72	3
FP72	3
FP72	3
FP72	3
FP72	3
FP52	3
FP72	3
FP72	3
FP72	3
FP72	3
FP422	3
FP422	3
FP322	3
FP322	3
FP72	3
FP72	3
FP72	3
FP72	3
FP622	3
FP722	3
FP522	3
FP422	3
FP422	

FP522	4
FP372	3
FP522	4
FP472	3
FP372	7
FP347	8
FP72	4
FP47	4

FP372	3
FP372	3
FP47	3
FP:2	3
FP47	3
FP372	3
FP522	3
FP372	3
FP47	3
FP47	3
FP47	3
372 o o	3
372 o o	3
FP72	3
FP:2	3
372 o o	3
372 o o	3
FP:2	3
FP372	3
FP47	3
FP47	3
372 o o	3
FP47	3

FP72	3
FP42	3

3	FP72		3
4	FP622		3
4	FP472		3
4	FP372		3
4	FP72		3
	FP472		3
	FP72		3
	FP72		3
	FP72		3
	FP72		3
	FP72		3
	FP47		3
	FP47		3
	FP47		3
	FP47		3
	FP47		3
	FP47		3
	FP47		3
	FP47		3
3	/		3
4	/		3
5	/		3
	FP422		3

507

50703

3				7	
4				///	
5				Mo	980:
				ol	43215
				ol	8213
				ol	8213
				ol	;213
				ol	;2215
				ol	372217
				ol	46:16

					22
					217
			ol		98
			Mo	8:090	
			o	3	
				2	
6				2	
7				53048	
				35:406	
			jo4		
8			jo4		
			jo		
			jo		
			jo		
			jo		

50704

63%

63%

FP522 3202ORc

FP722 805ORc

FP43;. 805ORc FP622. 805ORc

FP522. 308ORc

:			6:2		
;			482		
32					

4

5

6

ZZ

ZZ o

304 o

304 o

5

472 o

407 o

3

522

4

482

5

482

6

:2

7

482

8

482

9

593

482 82

:

5:

;

5825

82

32

62

33

977

58

--	--	--	--	--	--

“*”

50707

RG

RG

RG

RG

50708

72 82o



40
iv

4

5

ID7258;/4236

6

3 3

372 522 o o

207 o

307 o

508/3



9

72o

307ϕ306

6

203ORc

46

20285ORc

/37

47mo

:22o o

34782o5

:

50804



4

5



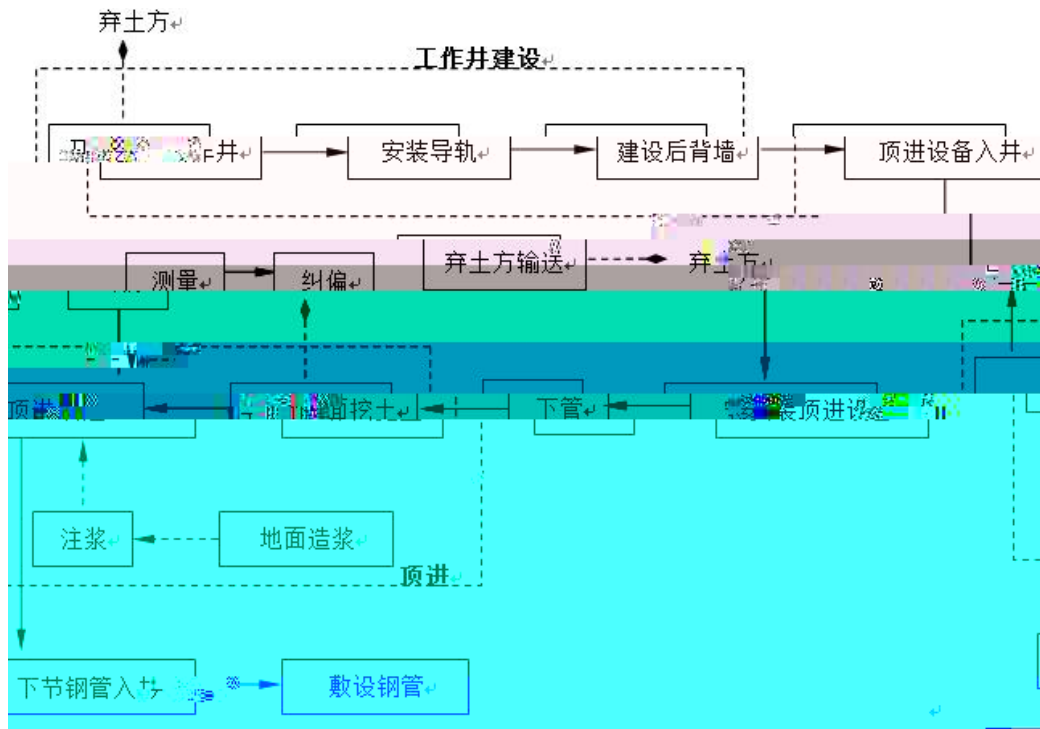
Pc4EQ5

6

7

8

6





*: o1 34o1



52 52o

37 37 4o

52 52o

37 37 4o

5o

307o

4

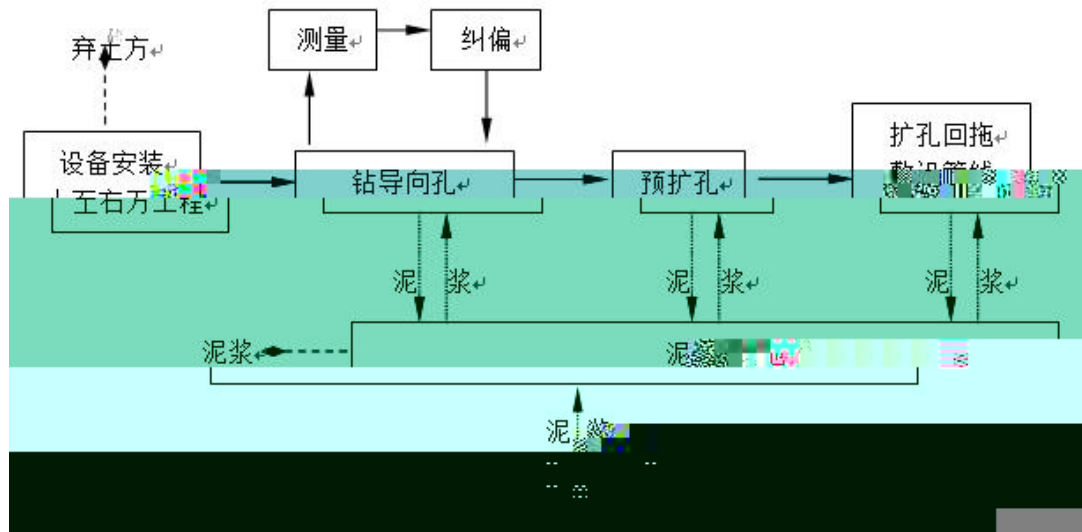
305 307

*

7'

*

E



7

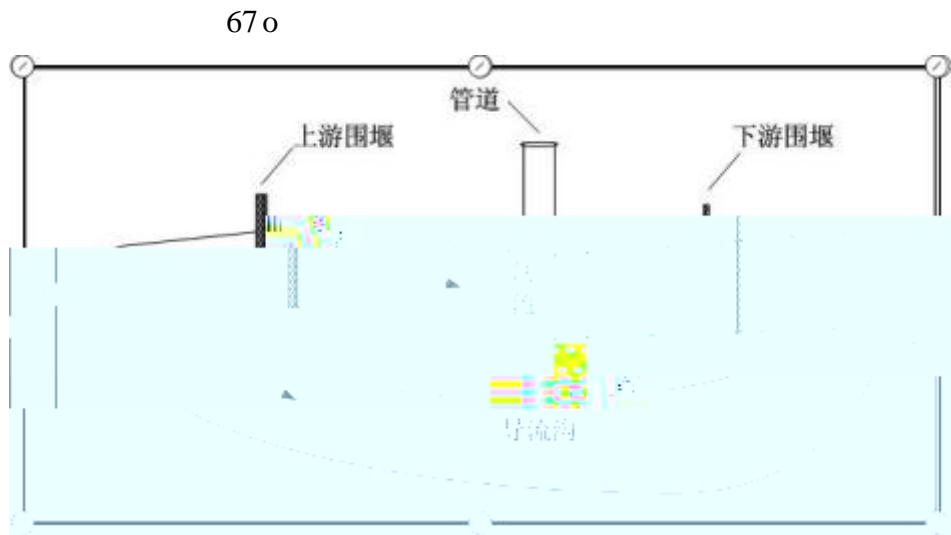
4

3

42o

32o

4



5

50806

3

3

NiáfAÑEs

4

205 o

5



7

8

9

:



;

4

ZZj o⁴

5

ZZj o⁴

ZZj o⁴

50;

3		mo	
4		mo	
5		mo	
6		mo	
7		mo	

5032

3

33;262 o

4;982 o

52eo

; ;04

355;42 o

5904 o

4974:2 o

;8942 o

4

52 508 o

7622 o

52eo

;222

5055 o

205 o

506

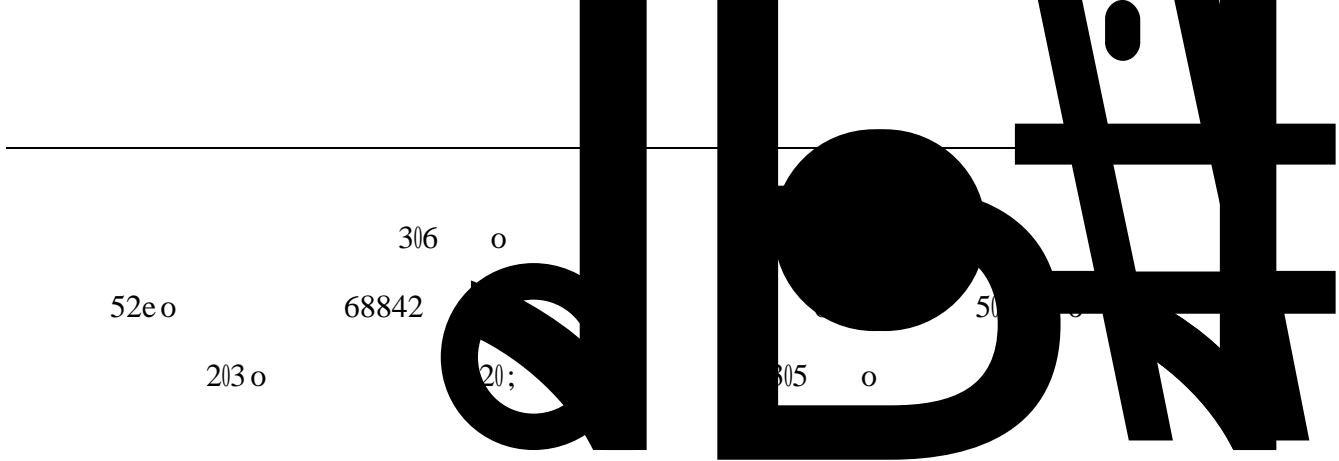
o

8722 o

504 o

205 o

5



6

5033

503303

32 o 1j o 4 f

5669 o 4 4;24 o 4

543806 o 4

5067 o 1f 40;2 o 1f 5044 o 1f

422f1c

3		304: o 1f	304: o 1f	402: o 1f
4		4 o 1c	4 o 1c	4 o 1c
5		5067 o 1f	40;2 o 1f	5044 o 1f
		6095 o 1f	603: o 1f	7052 o 1f
		337;04 o 1c	326;04 o 1c	362704 o 1c
		<i>365d/a</i>	<i>200d/a</i>	

6095 o 1f 337;04 o 1c 603: o 1f 326;04 o 1c 7052 o

1f 362704 o 1c

4

4 o 1c

3024 o 1f

3088 o

1f

503305

7:

32 6m Y j

32mX

3

5034

3

ID3:7;9/4223

*

4235

78 +

4

Ö32

5035

503503

3

3

4

5035/3 5035/4

4

:7ϕ322fD C

7mo

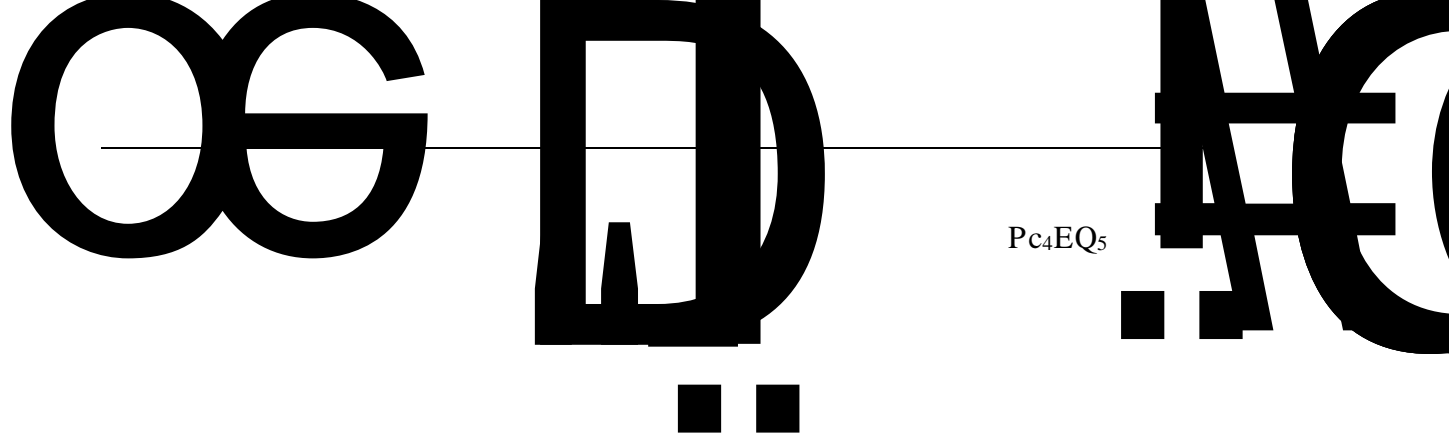
42f

42 62f

:7fD*C+

34 22ϕ36 22

44 22ϕ 8 22



Pc4EQ5

5

* + * +

*

205 207 o+

È

6

204v1m o

470:v

7

205:v1m o

6;058v

7

3

4

5

6

8

9



=

=

=

503504

3

3 34o

n

õ

ö

3

92P o

2094;6milo⁵

;049 '

6095mi

7

6095milc

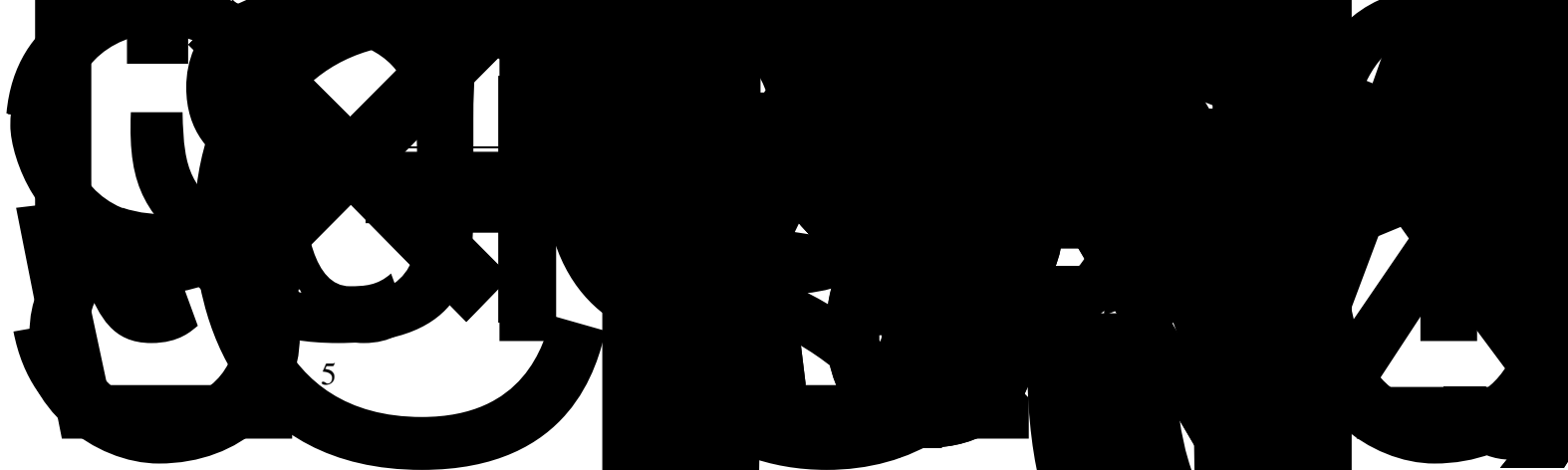
3603;milc

		7P o l	3 4 15c	-34o	303ilu	208:mi15c 4026mi15c
--	--	--------	------------	------	--------	------------------------

4

3

3



5

87 :7fD*

3

C+





J Y2;

5milc

;milc

*J Y6;+ 6 7

2027vlc

207mil

908vlc

4	J Y2 :	;22/4 32/2:	;milc					3	V K
5	J Y2 :	;22/4 35/2:	2037mi lc					lc	V K
6	J Y 6; 6;	;2 2/2 66/ 6;	2024m il5c					3 15c	V

4

ID3:7;9/4223

4

Ö32³²e o lu 3 o

503505

6095milc ô ô

34 o

20:3 milc ô ô

208:mi15c ô ô

UU

3:2 o i l N

4 o 5 lc

UU	4 o 5lc	3:2 o i lN
		47 o i lN
EQF	59405 o 5lc	522 o i lN
UU		482 o i lN
P J 5/P		72 o i lN

C	87 342fD*C+	ô ô
J Y 2;	407milc	ô ô
J Y 2;	5 milc	ô ô
J Y 2;	2027vlc	ô ô
J Y 6;	2024 vl5c	ô ô
	40; vlc	ô ô
	6095milc	ô ô
	20:3 milc	ô ô
	208:mi15c	ô ô
UU	4 o 5lc	3:2 o i lN
		47 o i lN
EQF	59405 o 5lc	522 o i lN
UU		482 o i lN
P J 5/P		72 o i lN
C	87 342fD*C+	ô ô
J Y 2;	407milc	ô ô

J Y2;	5 milc	ô ô
J Y2;	2027vlc	ô ô
J Y6;	2024 vl5c	ô ô
	40; vlc	ô ô
	6095milc	ô ô
		34o
	20:3 milc	ô ô
	208:mi15c	ô ô
UU	4o5lc	3:2o ilN
		47o ilN
EQF		522o ilN
UU	59405 o5lc	482o ilN
P J5/P		72o ilN
C	87 342fD*C+	ô ô
J Y2;	407milc	ô ô
J Y2;	5 milc	ô ô
J Y2;	2027vlc	ô ô
J Y6;	2024 vl5c	ô ô
	40; vlc	ô ô

4654 mo⁴

3

8;06

3;0:

31882

4 6

4

208 Ÿ

3306 5;06

5

6504//3506

4;0:

2097 '

31355;

6504//3506

6

õ

ö

60305

3

3206mo



;045



9mo

5409 mo

5307 mo

4



3308

8

630 3
39:

32 4

32 49

5307

3604

62

34 5

5 33

344

4



8;05

60607

3

4

52

InqdgNcpf52

5

5

:975079v



6060:

I KU

I KU

		,
	3: ;	322
	2	2
	2	2
	2	2
	3: ;	322

6060;

70403

7040303

3

7

80

42'

3'

4

n

72P o

2095;milo

308: '

2084mi

3

602ORc

32P o

2034mi

3 1

3 okp 5 okp

32~~4~~37P o 1

3 okp

37P o 1

5039ilu

203;mi

203;milc

7040304

3

JL404/422:

Uetggp5

Uetggp5

3622	205977	3608
3722	20584	36028
3822	205	350697
3922	20	340;4
3:22	20	3406
3;22	20	330;37
4222	204;58	5:047
4322	204:34	
4422	2048;7	
4522	2047:6	
4622	2046:	
4722	2045:5	
	20987 458 o	

FD3513799/4234

70404 FD[B'@âP\$ \$éà< Æ

7040404

3

ô

ô

ô

422ø522 o⁵lj

37

407

72 322 o⁵lj

42ø72 o⁵lj0o

32 42o

322 372 o⁵lj

72 :2 o⁵lj

7ø32 o⁵lj0o

72 :2o⁵lj

7 o⁵lj0o

S6

52 92o

S5

:2 422o

4

208 Ÿ

3306 5;06

42ç62o

342ç62o

3ç7o

42ç82o

7222

/

3

7

4

5

/

式(1) $C(x,t)$ — t 时刻 x 处的示踪剂浓度, $\text{mg} \cdot \text{m}^{-3}$;

x —距注入点的距离, m ;

M —注入的示踪剂质量, kg ;

w —横截面面积, m^2 ;

u —水流速度, $\text{m} \cdot \text{d}^{-1}$;

n —有效孔隙度, 无量纲;

D_L —纵向弥散系数, $\text{m}^2 \cdot \text{d}^{-1}$;

π —圆周率。

7040406

3

7

UU

*ID7

2022;29 o ilN

7

70405

87 :7fD*C+

332 342fD*C+



Ccvo

C

Cgze

3

Lt+?Lt 2+/42L*tlt 2+

Lt+?Lt 2+/32L*tlt 2+

m

L

$$L_1 = 10 \lg \left(\sum_{i=1}^k 10^{0.1L_i} \right)$$

L

L?L

VL8

VL o\$

4

*3+

5

$$A_{atm} = \frac{\alpha (r - r_0)}{100}$$

t

o

t2

o

ô 322

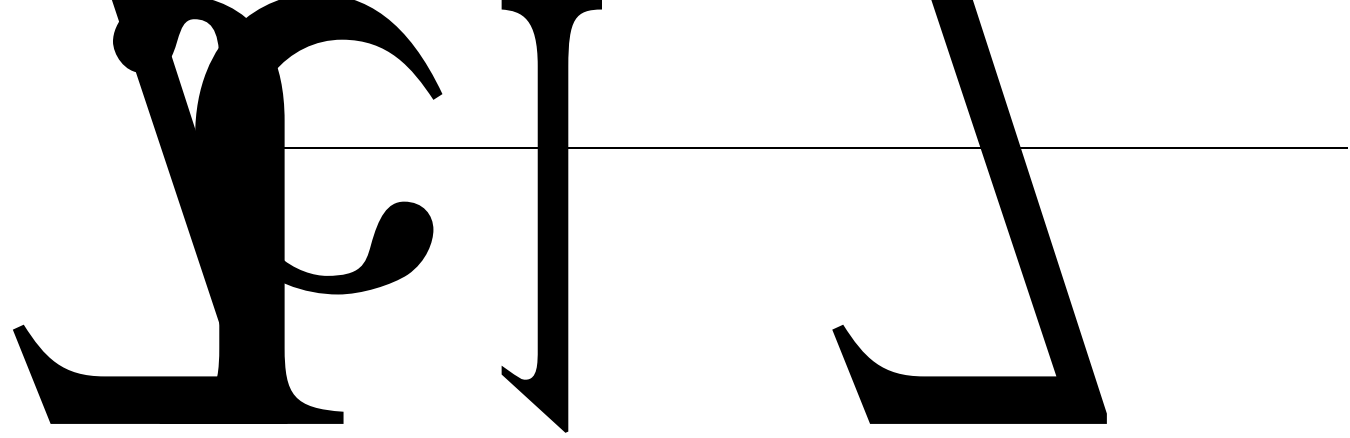
6

7040504

3

332 342fD*C+

52fD*C+



J Y2;

5milc

37milc

*J Y6;+ 6 7

2027vlc

207mil

7

908vlc





4

3

4



80307

0

3

52/72e o

7o

7o

4



52e o

80403

RG

80404

7

3

4 o 1

80405

ID3456:/422:

4

332 342fD*C+

322 o

ID52;8/422: 3

ID52;8/422:

37fD*C+ 3

82fD*C+

5308 o

80406

J Y2;

n 5

J Y2;

*J Y6;+ 6 7

--	--	--	--

ID3:43:/422;

903/6

JLIV38;/4226

M 30536 T :053L1o qn
m VI 4;5m
[?302
305:milu

EDM

3407mY1o4

3 DN n

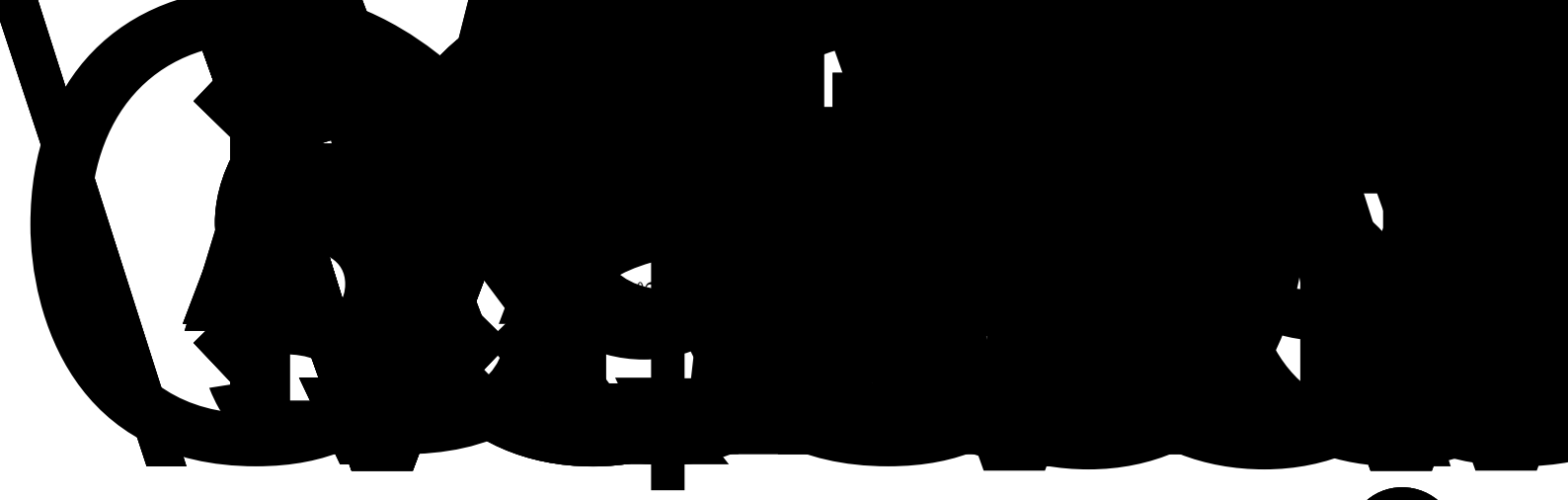
32



s my 2057
 Se milu Je 5904;OLmi
 k z
 Kk s Tl*6 z4+
 Kk k z mylo4
 s my T 204
 z o

ⁿ
 K Kk
 k 3
 p p 7
 7

K 7 s Tl*6 z4+ 7 Se Je Tl*6 z4+
 2057
 Se milu Je 5904;OLmi T 204
 z o



W

WOW

È

9077 o

;047 o 3

3502: o È

45034 o

58078 o

52ç4;7 o

;06 o

4:05 o È 9

720: o

3803 o

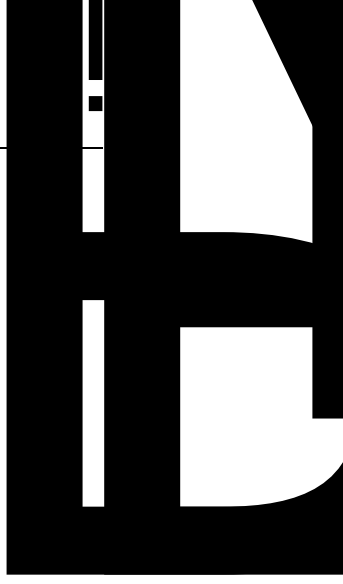
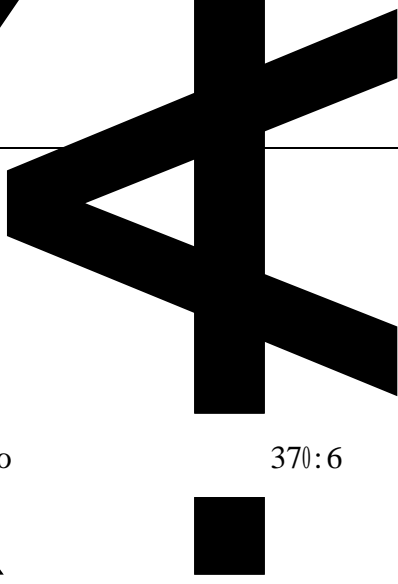
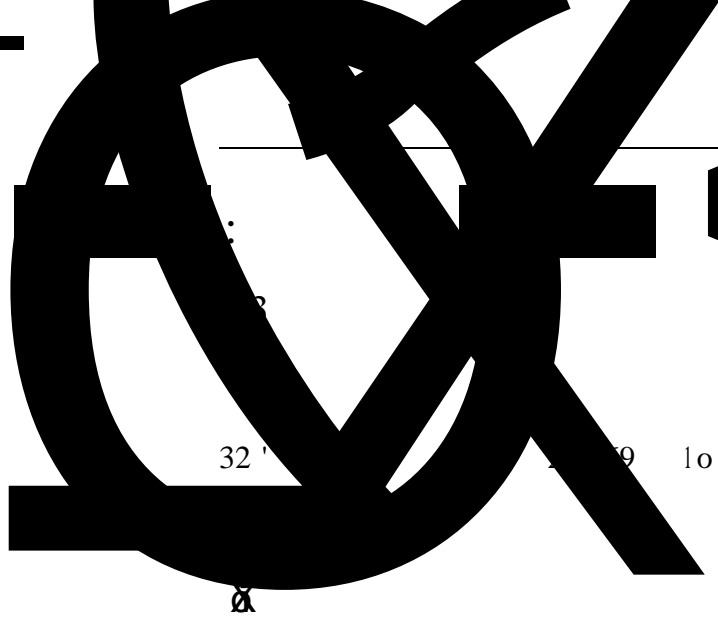
52 o

304 o





+ * * *
+ * * *
+ * * *



32'

2' 9" lo

370:6

Ø

,³/₄° C3"Y%\

DF° S00

;

;03

;0303

3

4

;0304

;0306



3

3

3

6

;0307

JUG

3/4

õ ö

3

4

;04

2vlc EQF2vlc 2vlc 2vlc 2vlc UQ42vlc
2vlc XQEu2vlc

;05

7

7

9309mo

7:04mo

5NRG

3

			42	72
		RG		
5				
		32o		3oilo
		ID384;9/3;;8	4	Ö302oilo
		UU		
		ô ô		
		NgsC		
		92fD*C+		77fD*C+

ID34745/4233

92fD*C+

77fD*C+

ô ô

ô ô

ô ô

EQF UU

EQF UU

ô

ô

ô ô

NgsC

82fD*C+

72fD*C+

ID3456:/422: 4

ID3:7;9 /4223

4235

6

XQE

u

4

5

6

7

8

32

3

10. 1.

3

42

o

5843;079

7

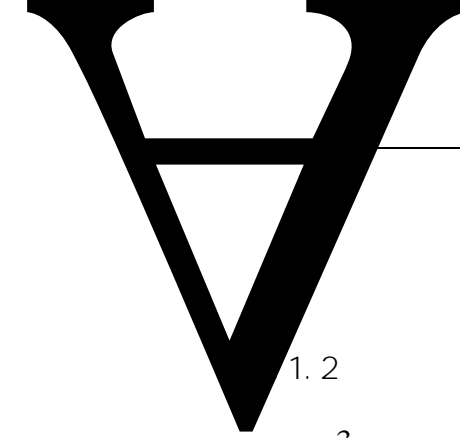
7

34;0;mo

9309mo

7:04mo

43



3

1. 2

3

3

UQ₄ PQ₄ EQ Q₅ 3 46 Q₅ :

3

FD3513799/4234

RO₃₂ RO₄₀₇ 46

ID52;7/4234

4

5

IDIV36:6:/;5

6

ID52;8/422: 4

82fD*C+ 72fD*C+

7

4

*ID52;7/4234+

*IDIV36:6:/;5+

ID52;8/422: 4

10. 1. 3

3

4

RG

10. 1. 5

322 '

10. 1. 6

10. 1. 7

10. 1. 8

4

5

6

7