

Drilling

A DRILLING EQUIPMENT

1	ACF-PAT 201 rotary drilling rig	709	5	Down-the-hole hammer	714
2	ACF-PAT 301 rotary-DTH mixed drilling rig	710	6	Three-bladed bits, for-bladed bits and tricone bits (2004)	715
3	ACF-PAT 401 PTO mixed rotary-DTH drilling rig	711	7	Threaded PVC borehole casing and screen (2004)	716
4	ACF-PAT 301 T	712			

This annex lists the materials and equipment needed for drilling programmes. The drilling rigs have been developed in collaboration with the firm PAT (Promotion of Appropriate Technology), based in Bangkok, Thailand (e-mail: pat@pat-drill.com, web site: www.pat-drill.com).

1 ACF-PAT 201 rotary drilling rig

The PAT 201 is the first of the PAT series, and the oldest. Its design (very light and easy to use), and its cost make it a machine particularly well suited to drilling in non-consolidated sedimentary terrains. The whole kit weighs less than a tonne, and can be transported in a pick-up truck.

ACF has developed 'itinerant' drilling programmes in Myanmar, transporting this rig from village to village by boat, and has also created numerous water points in Cambodia. This rig is particularly well-suited to isolated areas, such as the Bar El Gazal, in Southern Sudan, where boreholes equipped with hand-pumps have been drilled, or for water exploration before digging wells.



Figure 1: ACF-PAT 201 frame.



**Figure 2: ACF-PAT 201.
Three-bladed drilling bits.**

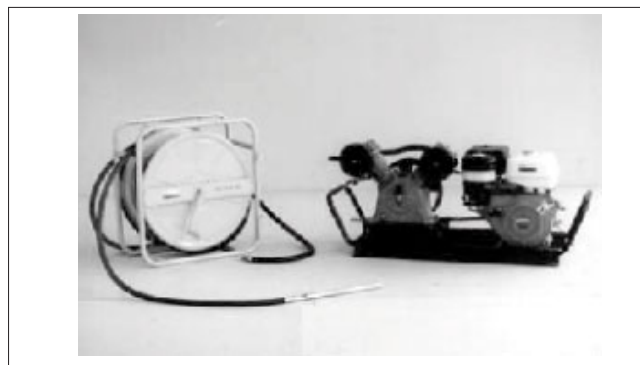


**Figure 3: ACF-PAT 201.
Development compressor.**

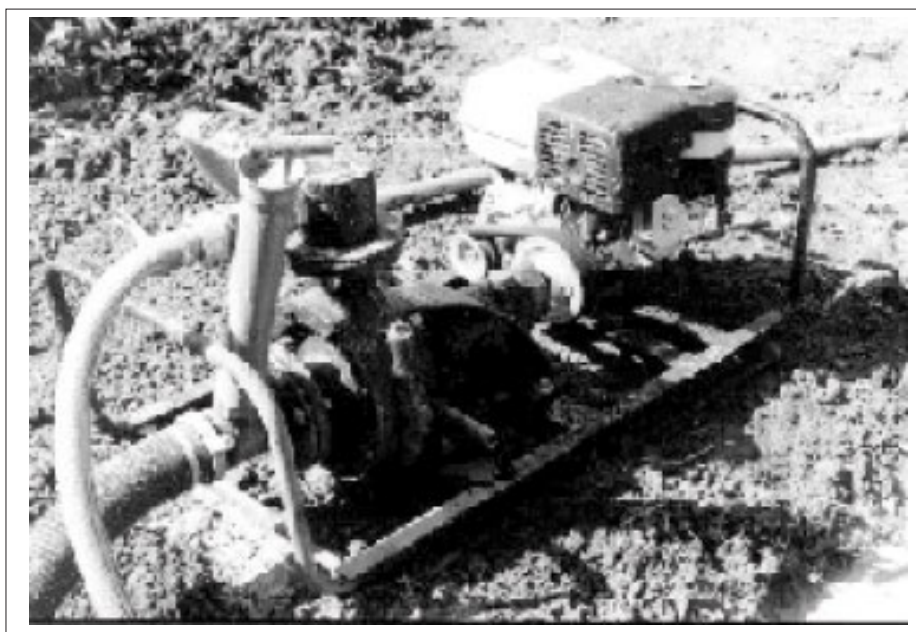


Figure 4: Mud pump.

Because of its design, the kit enables a quick start to a drilling programme. In addition to the drilling machine elements (frame, mud pump, development compressor, drill pipes, drill bits etc.), there are tools, spares and drilling consumables.

The machine, in this version, is limited to a depth of 60 m with a 6¹/₂ diameter. An improved version has been designed for drilling beyond this depth.

2 ACF-PAT 301 rotary-DTH mixed drilling rig

The ACF-PAT 301 is a portable DTH-hammer hydraulic rotary drilling rig, designed to work in a variety of geological contexts: non-consolidated formations (alluvia, weathered formations etc.) and consolidated formations (bedrock, old sedimentary formations etc.).

The rig is made up of separate elements: drilling mast, hydraulic unit, mud pump, and compressor. This facilitates transport in isolated or areas, or areas difficult to access. All the drilling accessories are supplied with the kit (rods, hammer, bits), and also some consumables (hydraulic oil, polycol, foam etc.). This rig can be mounted on a Toyota Land Cruiser pick-up or a truck, or can be set up directly on the ground.

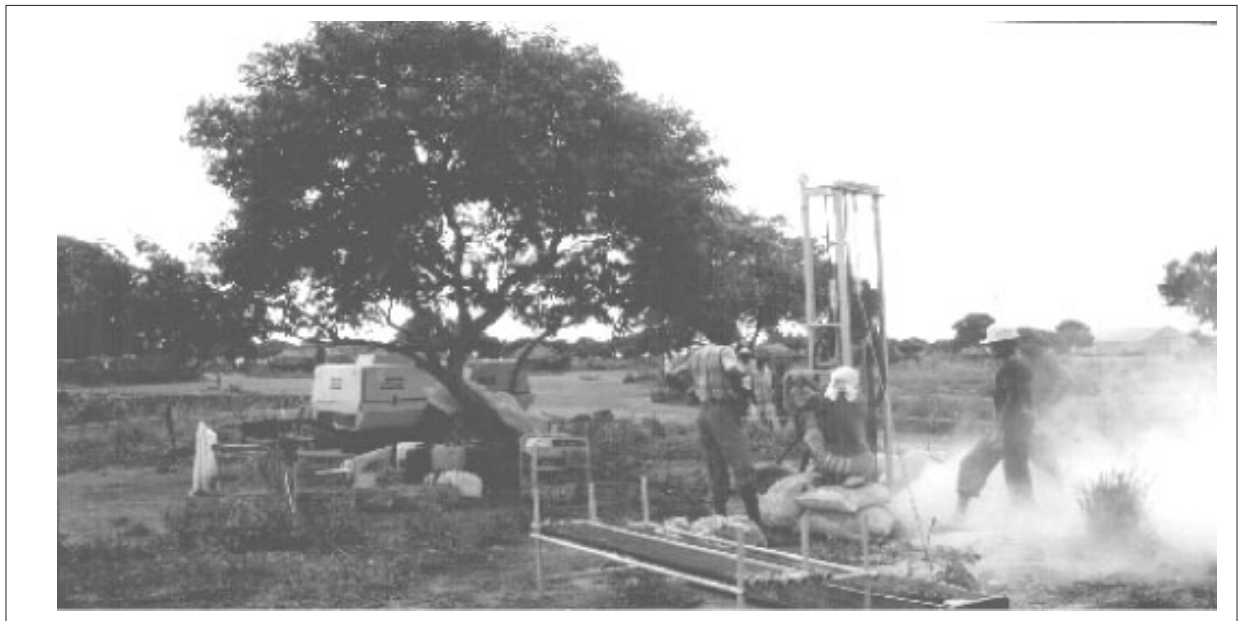


Figure 5: ACF-PAT 301. Rig on the ground.



Figure 6: Rig on a vehicle.



Figure 7: Rig, hydraulic pump, compressor.

3 ACF-PAT 401 PTO mixed rotary-DTH drilling rig

The ACF-PAT 401 is a drilling rig installed on an Toyota Land Cruiser pick-up or a Dyna light truck. The rig is powered by the vehicle engine via a power take-off which drives the hydraulic pumps for the rotation of the drilling head, raising and lowering the drilling rods, the stabilising jacks, and the mud and foam pump. This rig can be delivered on the drilling platform or directly on the vehicle (Dyna).

Assembling the rig on the Land Cruiser requires several days in a workshop. Modifications required to the vehicle are very few (reinforcement of the springs, power take-off, and installation of the platform on the chassis).



Figure 8: ACF-PAT 401. Rig on a Dyna truck.

Figure 9: Rig on a Land Cruiser.



This rig is more powerful than the PAT 301, it is more easily manoeuvrable, and the set-up time is less. The vehicle can be set level immediately with the jacks. The rig can be used in rotary mode, and in DTH 5" mode (165 mm bit). The drilling depth is more than 100 m in sedimentary formations.

ACF has used this rig in Angola (Dyna version), and Honduras (Land Cruiser version).

4 ACF-PAT 301 T

The PAT-Drill 301T combines an onboard power pack, drill pipe storage and foam pump on a single-axle trailer. This makes for a quick set up in most locations and is an ideal multipurpose rig for many water well drilling operations.



**Figure 10: ACF-PAT 301 T.
Rig in drilling position.**



**Figure 11: Rig
in transporting position.**

5 Down-the-hole hammer

Technical characteristics:

– length	1 012 mm.
– external diameter	114 mm.
– weight	54 kg.
– diameter of drilling done by ACF	150 and 165 mm bits.

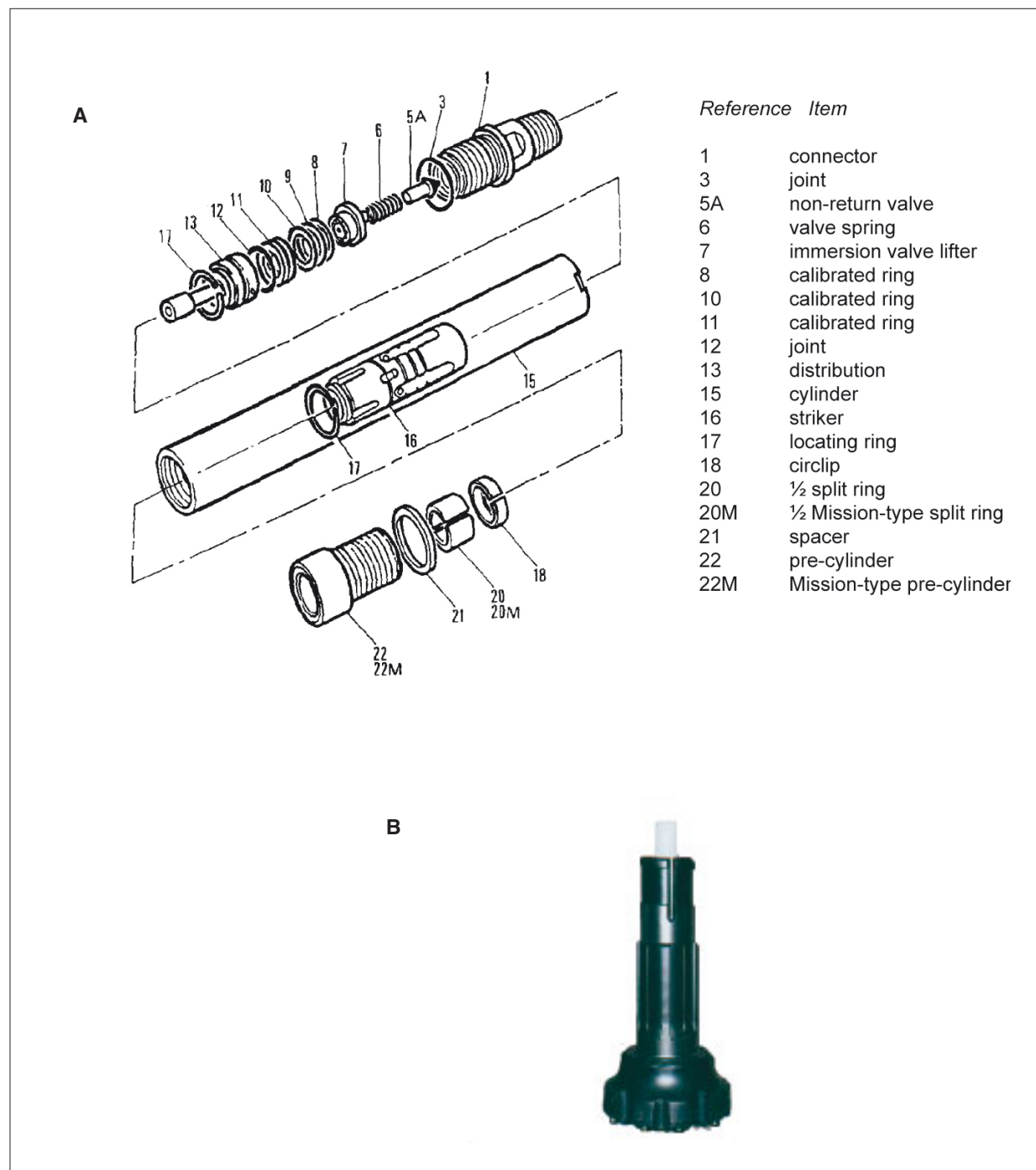


Figure 12: Down-the-hole hammer.

A: DTH-hammer parts list. B: drilling bit.

6 Three-bladed bits, four-bladed bits and tricone bits (2004)

Diameter (inches) (mm)		Thread	Unit cost (€)	Diameter (inches) (mm)		Thread	Unit cost (€)
THREE-BLADED BITS				FOUR-BLADED BITS			
3" 1/2 to 3" 7/8	—	2" 3/8R	141.50	3"	76.20	NROD	184.80
4" to 4" 3/8	—	2" 3/8R	148.70	3" 1/8	79.38	NROD	190.00
4" 1/2 to 4" 7/8	—	2" 3/8R	158.62	3" 1/4	82.55	NROD	189.00
5" to 5" 3/8	—	2" 3/8R	167.20	3" 1/2	88.90	NROD	194.40
5" 1/2 to 5" 7/8	—	2" 3/8R	172.91	3" 3/4	95.25	NROD	197.00
6" to 6" 3/8	—	2" 3/8R	180.10	3" 7/8	98.43	NROD	202.00
		3" 1/2R	230.10	4" 1/4	107.95	NROD	265.00
6" 1/2 to 6" 7/8	—	2" 3/8R	185.77	4" 3/4	120.65	NROD	295.00
		3" 1/2R	247.22				
7" to 7" 3/8	—	3" 1/2R	278.70				
7" 1/2 to 7" 7/8	—	3" 1/2R	294.40				
8" to 8" 3/8	—	3" 1/2R	310.10				
8" 1/2 to 8" 7/8	—	3" 1/2R	325.90				
9" to 9" 3/8	—	3" 1/2R	341.60				
9" 1/2 to 9" 7/8	—	3" 1/2R	357.25				
10" to 10" 3/8	—	3" 1/2R	371.60				
10" 1/2 to 10" 7/8	—	3" 1/2R	407.30				
11" to 11" 3/8	—	3" 1/2R	437.30				
12" to 12" 3/8	—	3" 1/2R	468.80				
12" 1/2 to 12" 7/8	—	3" 1/2R	484.50				
13" to 13" 3/8	—	3" 1/2R	515.90				
13" 1/2 to 13" 7/8	—	3" 1/2R	547.40				
14" to 14" 3/8	—	3" 1/2R	600.20				
14" 1/2 to 14" 7/8	—	3" 1/2R	628.76				
TRICONE BITS							
<i>Tricone bits with many small teeth, used for hard formations</i>				<i>Tricone bits with larger teeth, used for softer formations</i>			
3" 7/8	98.43	2" 3/8	270.00	3"	76.20	2" 3/8	170.00
4" 3/4	123.83	2" 7/8	356.00	3" 1/2	88.90	2" 3/8	170.00
5" 3/4	146.05	3" 1/2	418.00	3" 7/8	98.43	2" 3/8	170.00
5" 7/8	149.23	3" 1/2	482.00	4"	101.60	2" 3/8	192.92
6"	152.40	3" 1/2	580.00	4" 1/4	107.95	2" 3/8	192.92
		4" 1/2	114.30	2" 3/8	192.92		
		4" 3/4	120.65	2" 7/8	204.00		
		4" 7/8	123.83	2" 7/8	238.00		
		5" 1/2	139.70	3" 1/2	297.00		
		5" 7/8	149.23	3" 1/2	311.00		
		6"	152.40	3" 1/2	339.00		
		6" 1/8	155.58	3" 1/2	370.00		
		6" 1/4	158.75	3" 1/2	370.00		
		6" 1/2	165.10	3" 1/2	370.00		
		6" 3/4	171.45	3" 1/2	400.00		

7 Threaded PVC borehole casing and screen (2004)

- Net price ex-works.
- Basic length in stock; supplements for other lengths as follows: 2.90 m, 10%; 1.95 m, 15%; 0.95 m, 20%.
- 1-mm slotted screens; supplements for other slot sizes: 0.75/1.5/2/3 mm, 10%; 0.5 mm, 15%; 0.2/0.36 mm, 20%.

Size	Diameter (mm)	Thickness (mm)	Weight (kg/m)	Resistance (bar)	Length (m)	Type of joint	Price (€/m)	
							casing	screen
ND40, 1" 1/2	35 x 42	3.5	0.75	47	3.00	W	2.35	3.80
ND 50, 2"	52 x 60	4.00	1.05	23	3.00	W	3.13	4.72
ND 65, 2" 1/2	64 x 75	5.50	1.90	30	2.90	N	5.52	7.50
ND 80, 3"	80 x 90	5.00	2.05	13	2.90	M	5.91	8.25
ND 100, 4"	104 x 114	5.00	2.50	6	2.90	M	7.07	9.94
ND 112, 4" 1/2	112 x 125	6.50	3.50	8	2.90	M	9.28	12.28
ND 125, 5"	126 x 140	7.00	4.30	9	4	M	13.30	15.84
ND 150, 6"	150 x 165	7.50	5.40	7	4	M	15.37	19.07
ND 165, 6" 1/2	163 x 180	8.50	6.5	8	4	M	18.74	23.26
ND 175, 7"	178 x 195	8.50	7.30	6	3	M	23.17	28.92
ND 175, 7"	180 x 200	10.00	8.50	9	3	M	23.17	28.92
ND 200, 8"	205 x 225	10.5	10.2	8	3	M	31.00	38.67
ND 225, 9"	225 x 250	12.5	13.4	9	3	M	45.00	52.00
ND 250, 10"	255 x 280	12.50	15.90	7	3	M	53.00	69.70
ND 300, 12"	286 x 315	14.50	20.30	8	3	M	60.00	84.00
ND 350, 14"	389 x 400	10.50	18.50	1	3	M	63.80	87.00

B DRILLING LOG

DRILLING LOG N°

Location: _____
 Co-ordinates: _____
 Drilling officer: _____

Operation: from _____ to _____
 Drilling rig: Total time: _____
 Geologist: _____

Depth (m)	Time (min/rod)	Geological description (reaction to HCl)	Conductivity ($\mu\text{S}/\text{cm}$)	Water struck (estim. yield)	Observations (drilling technique, bit diameter, addition of polycol, foam etc.)	Casing plan
0						
2						
4						
6						
8						
10						
12						
14						
16						
18						
20						
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						
42						
44						
46						
48						
50						

Borehole depth:	m	Static water level:	m	Estim. yield:	m^3/h
Hydrogeological context:				Conductivity:	$\mu\text{S}/\text{cm}$
Dynamic water level:	m				

Head casing:	Height	Casing dia.	Borehole dia.	Gravel pack:	l
Casing	m			Size:	m
Screen/slot size:	m mm			Type:	
Settling casing:	m				

Comments:

C DEVELOPMENT FILE

BOREHOLE DEVELOPMENT FILE N°

Location:		Compressor:		Works: from		to	
Coordinates:				Total use time:			
Supervisor:							
Borehole depth: m		Static water level: m		Hydrogeological context:			
Location of screens:							

	Depth (m)		Time (min.)	Measured yield (litre/sec)	Dynamic water level (m)	Water clearness (clay, sand etc.)	Conductivity (µS/cm)
	pipe	hose					
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D BOREHOLE FILE



FIELD EXAMPLE

Cunene Province

LOCATION			
ADMINISTRATION		CO-ORDINATES (UTM)	
District:	Cuanhama	North:	8103291
Commune:	Sede	East:	545081
Locality:	O'Chiunga	Map:	446
No Borehole:	38A/99/BC		
TECHNICAL CHARACTERISTICS			
BOREHOLE		PUMP	
Depth (m):	31.08	Kind of pump: Volanta	
Static water level (m):	12	Cylinder depth (m):	27.8
Yield (l/h):	600	WATER	
Dynamic level (m):	24	Quality (E. Coli/100 ml):	0
AQUIFER		Conductivity (µS/cm):	1 068
Geology	Sedimentary	Piezometer	No
Location-type	From 18 to 29 m		
	Porous		
	Confined		
AROUND WATER POINT			
COMMUNITY MOBILISATION		POPULATION	
Committee:	Done day 22.12.1999	No of persons:	900
INSTALLATION		School:	5 km
Cattle trough:	For goats	Health post:	No
Washing area:	Yes	No of cattle:	1 222
Fence:	Done	No of goat/sheep:	3 323
DRILLING			
Topsoil	Geology	Equipment	WORK
			10-06-1999 0845 Start
Clay with medium sand		Screen	10-06-1999 1202 Stop
Clay			
Clay with medium sand		Casing	
Coarse sand			EQUIPMENT
Clay with fine and medium sand			Rig: PAT 401
			Drilling technique: Rotary
			Drilling fluid: Polycol
			Bits ("): 8.5
			Pipes: PVC, 4.5"
			Casing (m): 19
			Screens (m): 11
			Settling pipe (m): 1
			Centralisers: Yes
			Vol. gravel pack (l): 320
			Diam. gravel (mm): 2

Comments: