A Summary Look at Production Packers

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INTRODUCTION

A recent search through API publications and petroleum engineering handbooks revealed that no concise summary of production packer data was available to furnish a novice in the petroleum business a broad basic understanding of this specialized equipment field. It is, therefore, the primary purpose of this report to outline the various types of currently available production packers and to list under this outline the packers available from several manufacturers as an example of this classification method.

Also included are simplified cross-sectional drawings of the different major categories of packers with photographs of actual packers alongside for comparison. A method of packer designation that could be developed into an industry standard is offered for consideration.

Reference to a particular manufacturer's equipment is not intended as an endorsement of their products, nor is the omission of reference to any manufacturer's equipment intended as a condemnation of their product. All such references are included only as examples for clarification of this paper.

GENERAL

In order to catalog the many types of production packers, some logical method of grouping must first be established. The outline in Table 1 groups packers according to function and construction. Many other logical classification methods can be developed, but for the purposes of this paper only the classificiation outline in Table 1 will be used.

DEFINITIONS

In the petroleum industry the terminology and colloquialisms used in the describing and discussing packers vary widely between companies and geographic areas. This fact probably accounts for many misunderstandings and contributes to many misapplications of packers. Therefore, in order to clarify some of the terminology used in Table 1 and in the remainder of this paper, the following definitions are given:

Production Packer—a subsurface tool used to provide a seal between the tubing and casing (or wall) of a well to prevent the vertical movement of fluids past this sealing point.

Permanent Packer—a production packer that must be destroyed for removal; also called a drillable packer.

Retrievable Packer—a production packer that can be removed from a well by tubing manipulation or by any other means not involving the destruction of the packer.

Inflatible Packer—a special retrievable production packer with no hookwall slips whose seal is effected by the injection of fluid behind an expandable, ballooning, sealing element cylinder.

Cup Packer—a special retrievable production packer with no hookwall slips whose undirectional seal is effected by reinforcing metal springs and by increased pressure from the concave side of the cups.

Anchor (Isolation) Packer—a special retrievable production packer with no hookwall slips whose seal is effected by the compression of a solid resilient sealing element.

Hookwall Packer—a retrievable production packer with mechanical slips for hooking into the casing whose seal is effected by the compression of a solid resilient sealing element or by a cup packer element.

Tension Packer—a retrievable hookwall production packer that will not become unseated by an upward (tensile) force applied either by tubing tension or by pressure from be-

low the packer.

Compression Packer—a retrievable hookwall production packer that will not become unseated by a downward (compressive) force applied either by tubing weight or by pressure from above the packer.

Tension-Compression Packer—a retrievable hookwall production packer that will not become unseated by an upward or downward force applied by the tubing or by pressure acting from either direction on the packer.

Mechanically Set—requiring manipulation by tubing or wire line to activate packer setting mechanism and set the packer.

Hydraulically Set—requiring an applied hydraulic pressure differential to actuate packer setting mechanism and set the packer.

PACKER SELECTION

In order to intelligently select a production packer for a particular job it is necessary to know the details of the functions the packer will be expected to perform, the environmental conditions, and the mechanical design (casing size, weight, grade, etc.) of the particular well. Knowing these details, the selection can be made based upon the performance features of the packers available. Of course, the other factors that are not directly related to the operational aspects of the selection, but must inevitably be a part of any equipment comparison, are cost, delivery time, repair service availability, and past performance.

The various general types of production packers are illustrated in Figs. 1 through 9. For each major category of the classification outline, Table 1, a simplified cross-sectional drawing and a photographic example are given. A brief explanation of the design and operational features of each type packer is given. Also a few of the more common applications are listed. It should be understood that these cross-sectional drawings are gross simplifications of the actual packer mechanisms and that none of the parts' sizes, areas or angles are drawn to any scale. Many parts vital to the packer's proper operation have been left out entirely in the interest of simplicity.

PERMANENT PACKER

SIMPLIFIED CROSS-SECTIONAL DRAWING

EXAMPLE: BAKER "MERCURY" MODEL D PACKER

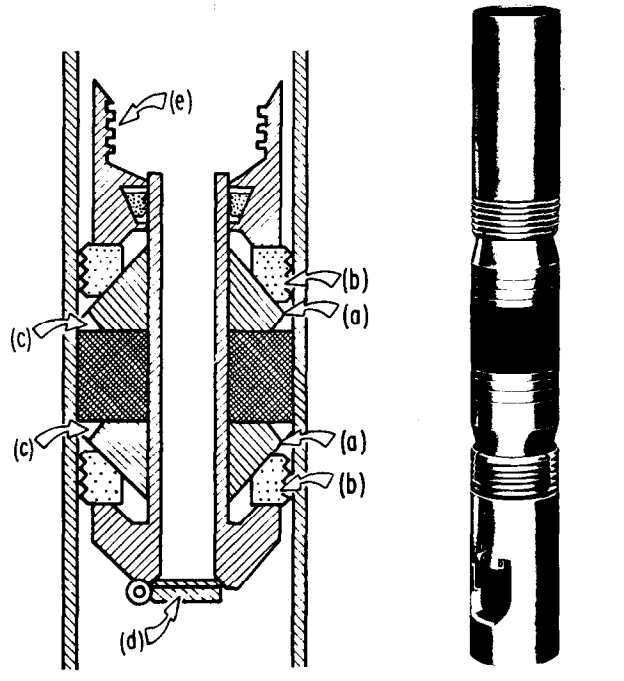


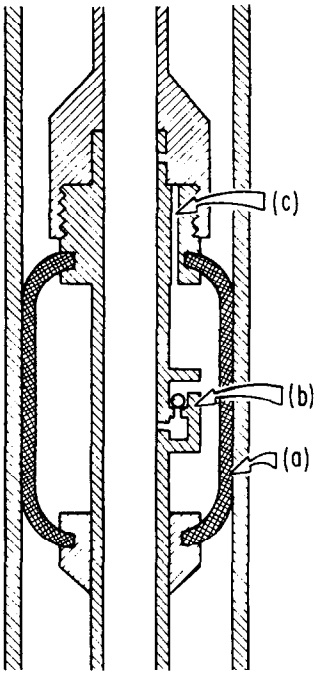
FIGURE 1

FEATURES: Packer sealing element is compressed between cones (a) which are locked in position by opposing slips (b) preventing movement in either direction. Expanding metal rings (c) contain sealing element and prevent excess extrusion. Flapper valve (d) prevents flow from lower zone when tubing is removed. Latch down threads (e) provide positive hold down for tubing seal assembly.

APPLICATIONS: Use where high pressure differentials and/or large tubing load variations require a maximum reliability of long life sealing and immovability. Use in deep wells where variations in tubing length can be handled by a long non-latching tubing-to-packer seal element. Use where exact location of packer is critical.

INFLATABLE PACKER

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: LYNES INFLATABLE PACKER SET IN OPEN HOLE

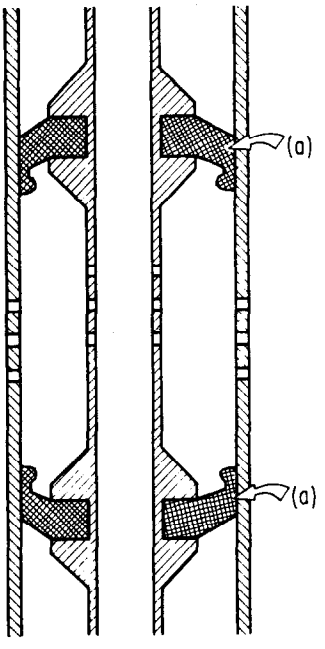
FIGURE 2

FEATURES: Expandable steel reinforced element (a) is forced against casing by pressure applied in tubing. Check valve (b) prevents backflow and deflation. Manipulation of tubing opens passage (c) and deflates element.

APPLICATIONS: Use in irregular open hole sections for water and gas shut off, selective treating and testing or impressions of fractures. Run through restricted areas and set in enlarged areas below.

CUP PACKER

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: GUIBERSON TYPE GW PACKER

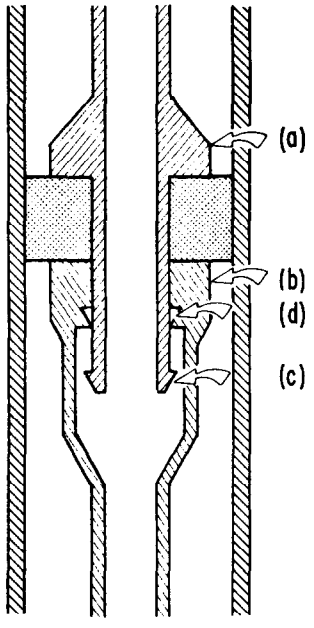
FIGURE 3

FEATURES: Steel reinforced rubber cups (a) contact casing while running and pulling and need no manipulation for setting. Each cup holds pressure from only one direction. Increasing pressure differential also increases seal between cup and casing.

APPLICATIONS: Use in moderate depth wells where moderate pressure differentials are expected and where pressures can be balanced or the tubing can be anchored against movement. Use where an inexpensive fluid or pressure seal is needed.

ANCHOR ISOLATION PACKER

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: OTIS TYPE MA PACKER

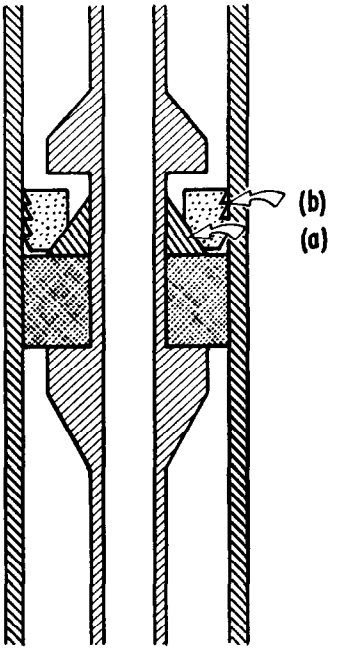
FIGURE 4

FEATURES: Packer sealing element is compressed between parts (a) and (b) when tubing below packer contacts a lower seat (packer, bridge plug, etc.) and collet (c) "snaps" out of receptacle (d) from weight of tubing above. No manipulation is required to set or retrieve. Tubing must be anchored by some other means against movement resulting from high pressure differentials.

APPLICATIONS: Use for upper packer to isolate perforation or casing leaks where high pressure differentials are not expected and where tubing need not be kept in tension. Packer is inexpensive compared to hookwall types.

TENSION PACKER

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: BAKER MODEL A PACKER

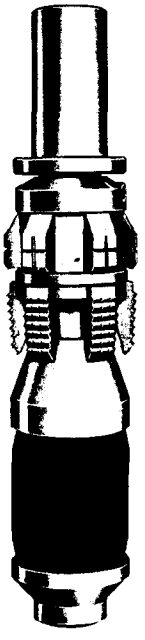


FIGURE 5

FEATURES: Packer sealing element is compressed between mandrel and cone (a) when slips (b) hook into the casing and tension is pulled in the tubing. Pressure from below tends to seal packer tighter while pressure from above can cause packer to lose seal.

APPLICATIONS: Use where pressure differential is expected from below packer (injection wells, stimulation treatments, etc.) or where tubing tension can offset pressure differential from above packer. Use where corrosive wells fluids must be kept away from packer slips and settling mechanism.

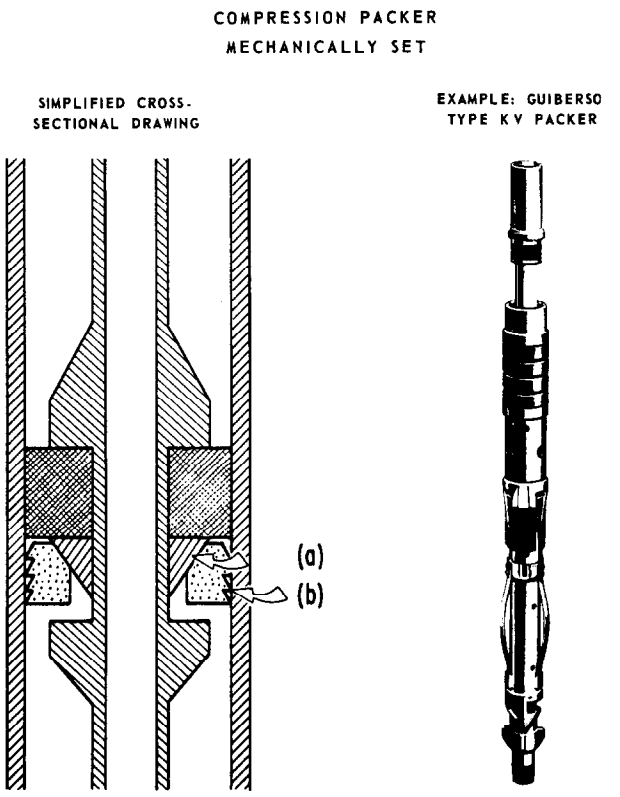


FIGURE 6

FEATURES: Packer sealing element is compressed between mandrel and cone (a) when slips (b) hook into the casing and tubing weight is applied to packer. Pressure from above tends to seal packer tighter while pressure from below can cause packer to lose seal. Can be equipped with hydraulic slips actuated by pressure from below packer. Will then hold pressure from either direction.

APPLICATIONS: Without hydraulic hold down, use where pressure differential is expected from above packer (low pressure flowing wells, swabbing operations, etc.) or where tubing weight can offset pressure differentials from below packer. With hydraulic hold down, use for stimulation treatments, swabbing, producing or isolating. Use as the upper dual or triple packers in multiple completions.

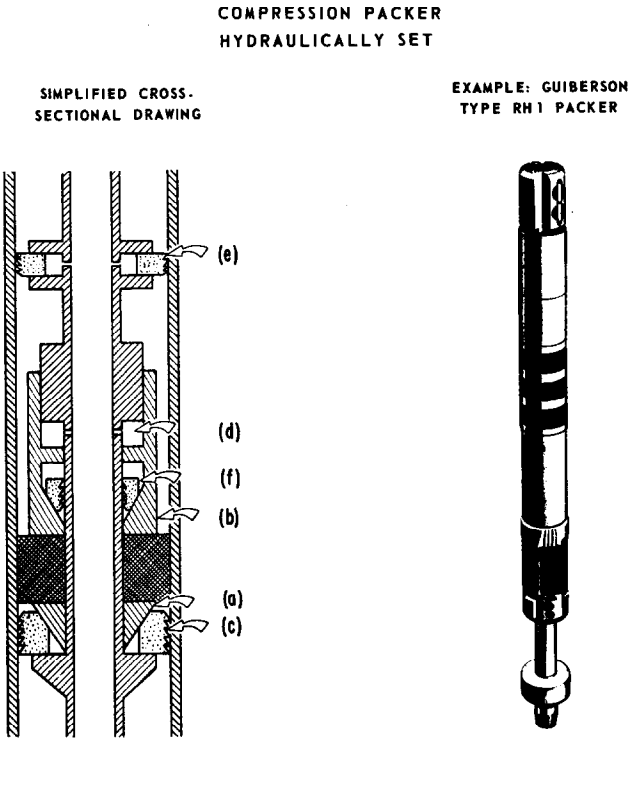


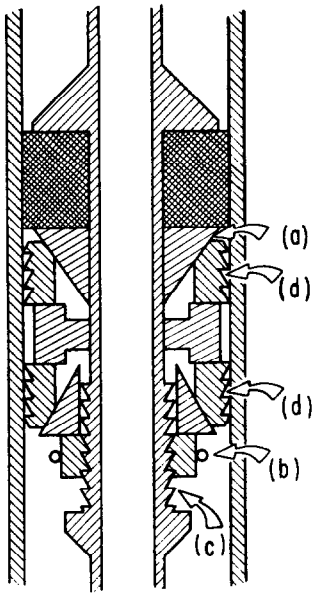
FIGURE 7

FEATURES: Packer sealing element is compressed between cone (a) and piston (b) as tubing pressure is applied. Pressure acting in chamber (d) forces piston (b) downward and slips (c) outward while hydraulic slips (e) hold mandrel in place and small slips (f) lock packer in set position. No tubing manipulation is required to set packer and no trapped pressure is required to maintain seal. Pressure from above tends to seal packer tighter. In illustration shown, pressure from below packer acts on hydraulic slips to hold mandrel stationary and maintain seal. The hydraulic hold down is not always included with this general packer type.

APPLICATIONS: Use where a seal is required for pressure differentials from above packer (either direction if HHD included), where tubing manipulation to set packer is undesirable, and where tension in the tubing string is not required.

TENSION AND COMPRESSION PACKER
MECHANICALLY SET

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: BAKER LOK-SET PACKER

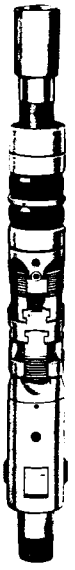


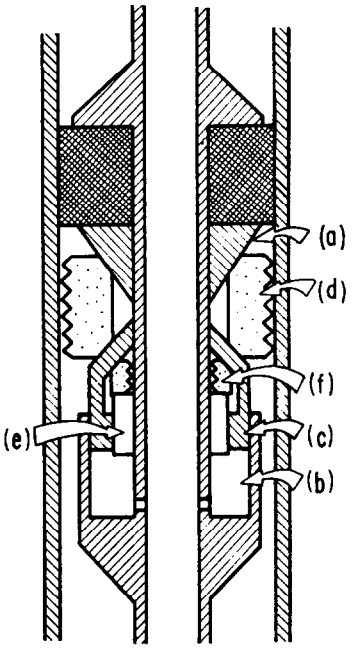
FIGURE 8

FEATURES: Packer sealing element is compressed between mandrel and cone (a) by segmented nut (b) moving upward and locking in left hand directional threads (c). Opposed slips (d) lock packer against movement by tubing tension or compression and maintain the packer seal against pressure differentials from either direction.

APPLICATIONS: Use where tubing may be in tension, compression, and/or neutral; where tubing may be removed and packer left in well; or where pressure differentials from either direction may exist. Use instead of permanent drillable packer where later removal may be difficult due to well conditions such as lost circulation.

TENSION AND COMPRESSION PACKER
HYDRAULICALLY SET

SIMPLIFIED CROSS-SECTIONAL DRAWING



EXAMPLE: BROWN TYPE H-1 "HUSKY" PACKER

FIGURE 9

FEATURES: Packer sealing element is compressed between cone (a) and mandrel as tubing pressure is applied. Pressure acting in chamber (b) forces piston (c) upward and slips (d) outward, while piston (e) locks packer in set position with small slips (f). In illustration, large slips (d) are bi-directional and prevent any movement of the packer while maintaining a seal against pressure differentials from either direction.

APPLICATIONS: Use where tubing may be in tension, compression, and/or neutral; where tubing may be removed and packer left in well; where pressure differentials may be from either direction; or where tubing manipulation to set packer is undesirable. Use instead of permanent drillable packer where the possibility of later removal may be difficult due to well conditions such as lost circulation.

CLASSIFICATION OUTLINE

OF PRODUCTION PACKERS

- I PERMANENT
- II RETRIEVABLE
  - A. INFLATABLE
  - B. CUP
  - C. ANCHOR (ISOLATION)
    - 1. Compression Set
    - 2. Hydraulic Set
  - D. HOOKWALL
    - 1. Tension - Mechanical
    - 2. Compression
      - a. Mechanical Set
        - (1) With Hydraulic Holddown
        - (2) Without Hydraulic Holddown
      - b. Hydraulic Set
        - (1) With Hydraulic Holddown
        - (2) Without Hydraulic Holddown
    - 3. Tension and Compression
      - a. Mechanical Set
        - (1) With Hydraulic Holddown
        - (2) Without Hydraulic Holddown
      - b. Hydraulic Set
        - (1) With Hydraulic Holddown
        - (2) Without Hydraulic Holddown

TABLE 1

With a basic understanding of the general types of packers that are available, the selection of a packer for a particular job can usually be narrowed down to those in one of the major categories fairly easily. To proceed further to a preliminary selection the following information on each packer must be known:

(1) general packer type (see classification outline, Table 1)

(2) number of fluid passages (single, dual, triple, etc.)

(3) direction of pressure containment (above or below)

(4) setting procedure

(5) releasing procedure

This information has been tabulated for a large number of the available packers from several manufacturers in Table 2. This tabulation shows how packer models of several companies fall into the same general categories of the classification outline. It also lists a recommended code designation for each packer model. This code designation provides in an abbreviated form all the pertinent information (enumerated above) that is required for a preliminary packer selection. The following section of this paper explains this packer designation method in detail.

It is beyond the scope of this brief summary paper to discuss in any further detail all the factors that should be considered in selecting production packers. It should be added, however, that even after a packer has been selected, the sales or engineering representative of the company whose equipment has been chosen should be consulted concerning the details of the job planned. These specialists can usually furnish more pertinent information than is available in their equipment catalogs. Also, new development in packers and accessory equipment is very rapid and formal brochures may not have been distributed on some new products.

PACKER DESIGNATION METHOD

The API designation methods for beam pumping units and for downhole sucker rod pumps have been big steps in the right direction. Intercompany communications between engineers, operations personnel, purchasing agents, and manufacturers' representatives have been improved considerably where there designation methods have been adopted. A similar code designation system for production packers should also improve communications by simplifying written references to particular types of packers and by establishing a common terminology for describing this equipment. To maintain a continuity within the industry the method suggested here is purposely similar to the existing API designation methods.

Table 3 lists the letter abbreviations used in the notation code recommended. Each packer designation code is divided into five groups. These groups, respectively, denote the general packer type, number of fluid passage areas, pressure containment capability, setting procedure, and releasing procedure. Each code letter is simply the first letter of the word it represents. Fortunately, there are only two descrip-

PRODUCTION PACKERS
JANUARY 1966

CLASSIFICATION OUTLINE	BAKER		BROWN		GUIBERSON		OTIS		T.I.W.	
	TYPE OR MODEL	RECOMMENDED DESIGNATION	TYPE OR MODEL	RECOMMENDED DESIGNATION	TYPE OR MODEL	RECOMMENDED DESIGNATION	TYPE OR MODEL	RECOMMENDED DESIGNATION	TYPE OR MODEL	RECOMMENDED DESIGNATION
I. PERMANENT	D D DA DA F FA H P	P-1-AB-E/L P-1-AB-PT P-(1·2·3)-AB-E/L P-(1·2·3)-AB-PT P-1-AB-E/L P-(1·2·3)-AB-E/L P-1-AB-10RDUU P-1-AB-10RDUU			A A	P-1-AB-E/L P-1-AB-12RU	WA WA WA WA TB	P-1-AB-E/L P-(1·2)-AB-E/L P-1-AB-PT P-1-AB-W/L P-1-AB-25RD	W W	P-1-AB-E/L P-1-AB-5RDUU1&R
II. RETRIEVABLE										
A. INFLATABLE	B (INF)	RI-1-X[1]-PT-U6R								
B. CUP	Cup	RV-1-X[1]-D-U			ON	RV-1-X[1]-D-U				
C. ANCHOR										
1. Compression Set	A (Com) B (Com)	RA-1-X[1]-D-U RA-1-X[1]-D-U			KAV	RA-1-X[1]-D-U	FA MA	RA-1-X[1]-D-U RA-1-X[1]-D-U	C H	RA-1-X[1]-D-U RA-1-X[1]-D-U
2. Hydraulic Set							HO HB	RAH-1-X[1]-PT-6RU RAH-1-X[1]-PT-6RU		
D. MODEWALL										
1. Tension - Mechanically Set	A (Ten) B (Ten) C (FBRC)	RTM-1-B-DJLU-DJRU RTM-2-B-U2-D2U1 RTM-1-AB-JRU-JL	Cam-Lok (Ten)	RTM-1-B-DJLU-DJRU	Shorty Tension AF	RTM-1-B-DJLU-DJRU RTM-1-B-6RU-DU	RA (Ten)	RTM-1-B-JRU-DU		
2. Compression a. Mechanically Set (1) With Hydraulic Holddown	R (Dbl Grip) MDO J K L	RCM-1-A(BE)-UJRD-U RCM-1-A(BE)-D-U RCM-2-A(BE)-D1-U2U1[2] RCM-2-A(BE)-D2-U2U1 RCM-3-A(BE)-D2·3-U3U2U1	Bull Weevil 4-AD DBL-9-2H DB-9-2H DBL-9-3H	RCM-1-A(BE)-UD-U RCM-1-A(BE)-6RDL-6RU RCM-2-A(BE)-D1-U2U1[1] RCM-2-A(BE)-D2-U2U1[1] RCM-3-A(BE)-D1·2·3-U3U2U1[2]	L with K-HHD KVL with K-HHD KV with K-HHD RLC-2 RDB-3 RDC-2	RCM-1-A(BE)-6RD-U RCM-1-A(BE)-6RD-U RCM-1-A(BE)-UJLD-UJR RCM-2-A(BE)-D1-U2U1 RCM-3-A(BE)-D2·3-U3U2U1 RCM-2-A(BE)-D2-U2U1	MCH MH LH SH TH	RCM-1-A(BE)-D-U RCM-1-A(BE)-UJRD-U RCM-2-A(BE)-D1-U2U1[2] RCM-2-A(BE)-D2-U2U1 RCM-3-A(BE)-D2·3-U3U2U1	CJ HDBL-2 HSDL-2 HSDL-3 C with HHD HDB	RCM-1-A(BE)-12RD-U RCM-2-A(BE)-D1-U2U1[2] RCM-2-A(BE)-D2-U2U1 RCM-3-A(BE)-D2·3-U3U2U1 RCM-1-A(BE)-D-U RCM-1-A(BE)-12RD-12RU
(2) Without Hydraulic Holddown	R (Single Grip) G M	RCM-1-A-UJRD-U RCM-1-A-UJRD-U RCM-1-A-D-U	PS-4 Duo-Pak PS-3 Cam-Lok (Com) DBL-9-2 By-Pass	RCM-1-A-5RD-U RCM-1-AB-5RD-U RCM-1-AB-5RD-U RCM-1-A-UJRD-UJL RCM-2-A-D1-U2U1[2] RCM-2-A-D1-U2U1	L KVL KV Shorty Production RLC-2 RDC-2	RCM-1-A-6RD-U RCM-1-A-6RD-U RCM-1-A-UJLD-UJR RCM-1-A-UJLD-UJR RCM-2-A-D1-U2U1 RCM-2-A-D2-U2U1	MO RA (Com) MC LA SA TO	RCM-1-A-UJRD-U RCM-1-A-UJLD-UJR RCM-1-A-D-U RCM-2-A-D1-U2U1[2] RCM-2-A-D2-U2U1 RCM-3-A-D2·3-U3U2U1	JSAC Hydra Seal DB-2 SD-2 SD-3 C	RCM-1-A-12RD-U RCM-1-AB-5RD-U RCM-2-A-D1-U2U1[2] RCM-2-A-D2-U2U1 RCM-3-A-D2·3-U3U2U1 RCM-1-A-D-U
b. Hydraulic Set (1) With Hydraulic Holddown	E E A-4 A-5 V KH	RCH-1-A(BE)-PT-U RCH-1-A(BE)-PT-6RU RCH-2-A(BE)-PT2-U2U1[2] RCH-2-A(BE)-PT-U2U1[2] RCH-3-A(BE)-PT3-U3U2U1 RCH-2-A(BE)-DU2PT2-U2U1	HS-17-2C HS-17-3C	RCH-2-A(BE)-PT-1·2-U2·5R1 RCH-3-A(BE)-PT-U3U2·5R1	RH-1	RCH-1-A(BE)-PT-U	RH RDH	RCH-1-A(BE)-PT-U RCH-2-A(BE)-PT2-U2U1	HD-1 D-2 D-3	RCH-1-A(BE)-PT-U RCH-2-A(BE)-PT2-U2U1 RCH-3-A(BE)-PT3-U3U2U1
(2) Without Hydraulic Holddown	A-4 KH	RCH-2-A-PT2-U2U1 RCH-2-A-DU2PT2-U2U1	HS-17-2	RCH-2-A-PT-1·2-U2·5R						
3. Tension and Compression a. Mechanically Set (1) With Hydraulic Holddown										
(2) Without Hydraulic Holddown	Lok-Set	RTCM-1-AB-DA&RUD-U6R	Husky M-1 B-4	RTCM-1-AB-6RDL-U1&RDLU RTCM-1-AB-6L-6R	RMC-1	RTCM-1-AB-JRD-JRU	FW FR	RTCM-1-AB-E/L-U[4] RTCM-1-AB-12RU-U[4]		
b. Hydraulic Set (1) With Hydraulic Holddown			HS-16-1	RTCH-1-A(BE)-PT-U2·4&R						
(2) Without Hydraulic Holddown			Husky H-1 Husky H-2 HS-21-2C	RTCH-1-AB-PT-U6R RTCH-2-AB-PT2-U2·6RU1 RTCH-2-AB-PT-D2·12R1	RH-2[3] RH-3[3]	RTCH-2-AB-PT2-U2U1[2] RTCH-3-AB-PT3-U3U2U1	PH	RTCH-1-AB-PT-U[4]		

(1) No slips. Pressure differentials limited.
(2) Can also be retrieved on short string.
(3) Use hydraulic holddown for setting. It is not necessary (though helpful) to holding pressure from below packer.
(4) Can also be retrieved on sand line.

TABLE 2

PRODUCTION PACKER DESIGNATION METHOD

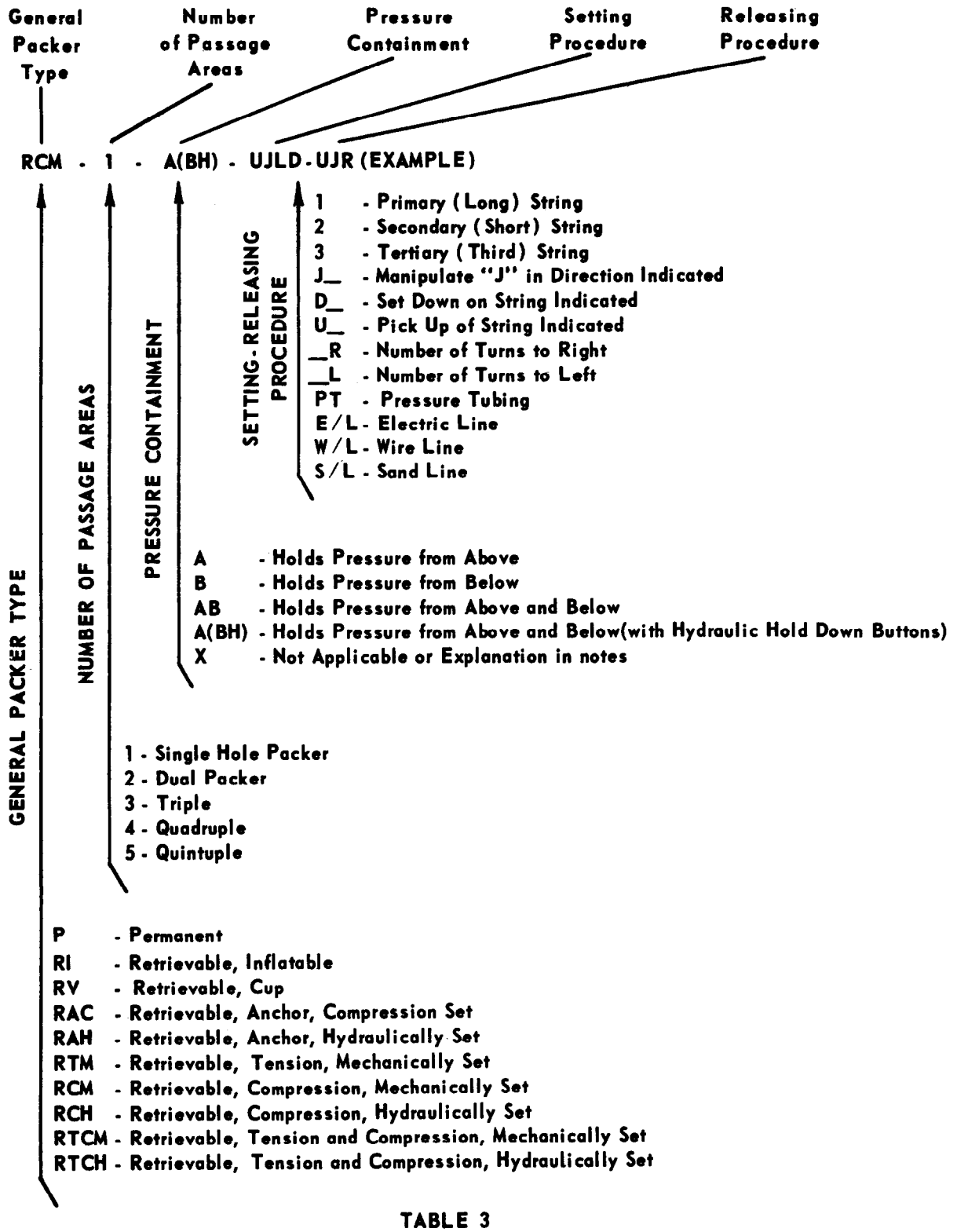


TABLE 3

tive words which start with the same letter; cup and compression. The cup type packer has arbitrarily been given the letter code "V".

The example packer designation in Table 3 is RCM-1-A(BH)-UJLD-UJR. The first group, RCM, indicates the packer is a retrievable, compression, mechanically set type. The second group, 1, denotes a single string, one hole packer. The third group, A(BH), indicates the packer will hold pressure from either above or below and that its ability to hold pressure from below depends upon hydraulically actuated slips. For the purposes of this paper a packer is considered to be capable of holding pressure when a pressure differential can be contained without the aid of tubing weight or tension. The fourth group indicates the setting procedure to be: pick up, unjay (¼ turn) to left, and set down weight on the packer. The fifth group denotes the releasing procedure to be: pick up, and jay (¼ turn) to right.

If it is felt that this letter code designation method is too complicated for practical use, perhaps the two code groups indicating setting and releasing procedures could be omitted. However, a simple record of this data in the well files could prevent difficulty in removing or resetting packers at some later date.

CONCLUSIONS

1. Production packers fall into several distinct categories when grouped according to function and design.

2. Packer terminology can be standardized for better communications within the industry.

3. Packer selection can be simplified by summary lists which provide comparative data on each manufacturer's equipment.

4. A letter-code method for designating the primary design and functional features of packers greatly simplifies written reference to particular production packers.

ACKNOWLEDGEMENT

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