F b g b k l _ j k l \ h g Z u k d b] h m [j Z a h \ Z g b y J h k k b c k d h c N _ ^ _

N _ ^ _ j Z e v g h _] h k m ^ Z j k l \ _ g g h _ [x ^ ` _ l g m h _ h [j Z a h \ Z l _

K h ^ _ j ` Z g b _

< \ _ ^ _ g b _ 4
H [s b _ i h e h ` _ g b y 5
H i b k Z g b _ e Z [h j Z l h j g h c _ j Z [h l u 6
I j b f _ j j Z k q _ l Z 9
K i b k h d b k i h e v a h \ Z g g u o _ b k l h q g b d h \ 11

<_^_gb_

MlbebaZpby ijhfure_gguo hloh^h\ hkh[_ggh mq ijhfure_ggh]h ijhba\h^kl\Z y\ey_lky djZcg_ Zd lh\k_f_klgbZqbl_evgu_ iehsZ^b a_f_evguo m]h^bc reZdh\ f_lZeemj]bq_kdbo ahehreZdh\uo kf_k_c l_i LWK \kdjurguo b \f_sZxsbo]hjguo ihjh^

< lh `_ \j_fy fZl_jbZeu gZoh^ysb_ky \ wlbo y\eyxlky p_gguf kujv_f ^ey ijhba\h^kl\Z kljhbWl_evg iha\hey_l gZm^h\e_l\hjblv ihlj_[ghkl10 kuj^30% kgbablv aZljZlu gZ ba]hlh\e_gb_ kljhb\l_ejZdgogbZl ijhba\h^kl\hf bo ba ijbjh^gh]h kujvy khdjZlblv h \eh`_gb30 ^50%.

B _keb \hijhk k bkihevah\Zgb_f ^hf_gguo]jZgm ^ey ijhba\h^kl\Z ihjleZg^p_f_glZ b [_lhgh\ ^Z\gh b \hijhk mlbebaZpehreZdh\uo hloh^h\ LWK lj_[m_l k\h

Mqblu\Zy i_kljhlm obfbq_kdh]h b fbg_jZeh]b fbg_jZevghc qZklb m]e_c Z ke_^h\Zl_evgh b ahe jZaebqguo m]hevguo f_klhjh`^_gbyo lZd b \ f_klhjh_^gby jZajZ[hldZ mgb\_jkZevguo j_dhf_g^Zpb ahehreZdh\uo hloh^h\ g_\hafh`gZ L_f g_ f_g__ \ kemqfZ`gh \hkihevah\Zlvky h[sbfb j_dhf_g^Zpbyfb i lh]h eb[h bgh]h \b^Z ahehreZdh\uo-mlghk^uevaLWK reZf reZdb ahehreZdh\u_ kf_kb ^ey ijhba\h^kl ghf_gdeZlmju kljhbl_evguo fZl_jbZeh\

H[sb_ iheh`_gby

AhehreZdh\u_ hloh^u \ aZ\bkbfhklb hlloh^oy_sfuo h
]Zah\ dhlehZ]j_]Zlh\ LWK fh]ml [ulv ij_^ghZZbe_g
ahevguf reZfhf reZdZfb ahehreZdh\ufb kf_kyfb

Ijb kmohc ko_f_ iue_meZ\eb\Zgby hloh^u ij_^
mghkZfb dZd ijZ\beh \ukhdhc kl_i_gb ^bki_jkghkl
mghkh\ g_ \uau\Z_l hkh[uo ijh[e_f ihwlhfm hgb
ijbf_g_gb_l_ogheh]bb yq_bkluo [_lhgh\ \ dZq_kl_
ijhba\h^kl_ ihjleZg^p_f_glZ \ dZq_kl_ Zdlb\ghc fb

FhdjZy ko_fZ iue_meZ\eb\Zgby b [he__f ijh
kmoZygh jZ[hlZlv k ahevguf reZfhf Z \ihke_^kl\bb
bf_xs_c \ukhdmx \eZ`ghklv b aZ\bkZxsmx \ [m
kf_jaZxsmxky b k ljm^hf ih^^Zxs_cky i_j_j
aZljm^gbl_evgh L_f g_ f_g__ ^Z`_ lZdmx ahem
ijhba\^kl_ [_lhgZ ihkdhevdm kmoZy ko_fZ iue_meZ
j_^dh b -amhehuku iheghklvx bkihevamxlky eb[h ijb
ihjleZg^p_f_glZ\ eb[hheh]bb yq_bkluoj_[hlehZ^Z_ll
fhdjZy ko_fZ iue_meZ\eb\Zgby b \ hl\ZeZihjydlZbebfkevj^m`
hloh^h\ ?`_]h^gh h[jZam_lkyl_ahehdeZdh\ue kf_k_c

GZb[he__ ijhklhc b ^hklZlhqgh gZ^_`ghc ko
ahehreZdh\uo hloh^h\ jZaebqgh]h njZdpbhggh]h
l_ogheh]by [_lhghZevah\Zgb_ ^bki_jkguklZ\ahe[_\hgkZ
iha\hey_l khdjZlblv jZkoh^ p_f_glZ b \ jy^_
kms_kl_ggh lZd dZd]b^jhdkb^ dZevpby \u^_eyx
debgd_jguo fbg_jZeh\ Zdlb\bjm_l fbg_jZeu aheu l
]b^jZ\ebq_kdmx Zdlb\ghklv ;hdhgahkeu ^hZZjZdl_jba
ihgb`_gghc ijhqghklvx \ jZggb_ kjhdb l_j^_gby
\y`ms_f p_f_gl aheZ ihgb`_gh kh^_j`Zgb_ debgd_
gh \ [he__ iha^gb_ kjhdb l_j^_gby ijhqghklv [_lhgZ

ij_\ahclb ijhqghklv [_alhgZ[Z\db aheu B [_lhg h
ih\ur_gghc iehlghklvx \ kjZ\g_gbb k [_a^h[Z\hqguf
lZdhc [_lhg j_dhf_g^m_lky bkihevah\Zlv ^ey \ha_^
khhjm`_gbc

< gZklhysbo f_lh^bq_kdbo mdZaZgbyo ijb\h^blk
ih^[hjZ khklZ\Z [_lhgghc kf_kb k ^h[Z\dhc aheu LWK

HibkZgb_ eZ[hjZlhjghc jZ[hlu

lh^[hj khklZ\Z [_lhgghc kf_kb ijh\h^blky
ihke_^h\Zl_evghklb

KgZqZeZ jZwqkl_hbf_glZevguf f_lh^hf ijhba\h^b
[_lhgZ gZ ljZ^bpbhgguoij^eyjbZlgyh]eb[h ijbgkhfZlZ\ky
[_lhgZ m`_ ijhba\h^bfh]h gZ wlhf hi[_ijbkyhkbZ\ [_l
ijbgbfZ_lky aZ bkoh^guc

AZl_f jZkkqblu\Zxl b ba]hlh\eyxl q_luj_ khklZ\Z
qZklv p_f_glZ aZf_g_gZ ahehc gZ JZkoh^
kf_rZggh]h \y`ms_]h ijb wlhf khojZgyxl jZ\guf jZk
khklZ\JZkoh^ \h^u ih^[bjZxl bkoh^y ba ^hklb`_gl
[_lhgghc kf_kb jZ\ghc \ bkohf^gehf\bkyhkbZ_`bf l_j^_
[_lhgZ ijbgbfZxl h^bgZdh\ufb k ijbgyllubfb gZ ij_^ijby

GZ[jZ\rb_ ijhqghklv h[jZapu \ \hajZkl_ -12km lh
qZkh\ ihke_ ijhiZjb\Zgby bkiulu\Zxl gZ k`Zlb_ b \uq
wnn_dlb\ghklb bkihevah\Zgby p_f_glZ ih nhjfme_

$$Кэ = \frac{R}{Ц}, \qquad (1)$$

]^R ±ijhqghklv [_lhgZ ijb k`Zlbb \ k_jbb FlZ
P ±jZkoh^ p_f_glZ [_dl]hgZ f lhc `_ k_jbb

<u[bjZxl gZb[hevr__ agZq_gb_ dhwnnbpb_glZ w
$Э_{макс}$

b ih g_fm ijbgbfZxl hilbfZevguf kh^_j`Zgb_ aheu kf_rZggh]h ahehp_f_glgh]h $3У^{опт}$\y`ms_]h

ljb wlhf ijhqghklvgZ_ lhgZhp_f_glghf \y`ms_f hilb khklZ\Z fh`_l hdZaZlvky gb`_ ijhqghklb bkoh^gh]h [

>Ze__ \uqbkeyxl jZagbpmglZ kûP^Z\ pkhfklZ\Zo bk P[b k hilbfZevguf kh^_j`Zgb_N f. \y`ms_]h P

AZl_f ba]hlZ\eb\Zxl _sz g_kdhevdh hiulguo aZ ihemqblv [_lhg aZ^Zgghk khiZqgyk ljb wlhf hilbfZevg kf_rZggh]h ahehp_f_glgh]h \y`ms_]h

>ey ihemq_gby [_lhgZ aZ^Zgghc ijhqghklb ^hihegbl_evguo khklZ\Z \ dhlhjuo jZkoh^ kf_r m_ebqb\Zxl ih kjZ\g_gbx k khklZ\hf k hilbfZevg \y`msbfk gZb[hevrbf (N) JZkoh^ \h^u ih^[bjZxl bkoh^y ihemdpygjZ\ghih^\b`guo [_lhgguo kf_k_c

JZkoh^ p_f_glZ \ i_j\hf b \lhjhf ^hihegbl_evguo $Ц_1$ $Ц_2$ d] gZ[3] [_flhgZ khhl_lkl_ggh jZkkqblu\Zxl ih nhjfm

$$Ц_1 = Ц_N + \frac{\Delta Ц}{3}$$

(2)

$$Ц_2 = Ц_N + \frac{2\Delta Ц}{3}$$

(3)

JZkoh^ aheu ^ey ^\mo ^hihegbl_evguo [3] [aZhfgZh\ jZkkqblu\Zxl ih nhjfmeZf

$$m'_{3у} = \frac{Ц_1 * 3у^{опт}}{100 - 3у^{опт}}$$

(4)

$$m''_{зу} = \frac{Ц_2 * Зу^{опт}}{100 - Зу^{опт}}$$

(5)

]^ Зу^опт ±kh^_j`Zgb_ aheu \ ahehp_f_glghf \y`ms_ khklZ\Z \

JZkoh^ i_kdZ \ wlbo khklZ\Zo mf_gvrZxl \ kjZ khklZ\hf gZ _ebqbgm ¨l \ d] gZ f [_lhgZ dhlh nhjfmeZf

$$\Delta П' = \frac{Ц_1}{\rho_0^{ц}} + \frac{m'_{зу}}{\rho_0^{зу}} - \frac{Ц_б}{\rho_0^{ц}} * \rho_0^{П}$$

(6)

$$\Delta П'' = \frac{Ц_2}{\rho_0^{ц}} + \frac{m''_{зу}}{\rho_0^{зу}} - \frac{Ц_б}{\rho_0^{ц}} * \rho_0^{П}$$

(7)

]^ $\rho_0^{ц}$ – bklbggZy iehlghklv kjf_f_glZ]

$\rho_0^{зу}$ - kj_^gyy iehlgh-kmgakhZeu] kf

$\rho_0^{П}$ ±kj_^gyy iehlghklv i._kdZ] kf

?keb jZkoh^ i_kdZ kh]eZkgh jZkq_lm khklZ\be [_lhgZ lh g_h[oh^bfh khhl_lkl_ggh mf_gvrblv jZ jZkoh^ i_kdZ jZ\guf d]

AZl_f nhjfmxl h[jZapu b hj]Zgbamxl bo l_j^_g j_`bfm lhke_ bkiulZgby h[jZaph\ kljhyl ]jZnbd aZ [_lhgZ ba kf_k_c aZ[hZggheZ^um\Z_fhklb hl kh^_j`Zg p_f_glZ \u[bjZxl jZkoh^ p_f_glZ h[_ki_qb\Zxsbc l b mlhqgyxl jfZkohb^Zeh\ gfZ[_lhgZ

Ijbf_j jZkq_lZ

Hij_^_ebhlvbfZevguc jZkeh^\ ijhiZjb\Z_fhf [_lhg_
ijb bkoh^ghkfZ_ [_lhgZ p_±f_gl s_[_±gv i_kh±d
\h±ZOO.

J_amevlZlu bkiulZgby [_lhgZ bkoh^gh]h khklZ\Z
p_f_glaZhehc dhebq_kl_ b ih fZkk_ ij_
lZ[ebp_

FZdkbfZevgh_ agZq_g_bg_lZdhwwnmn_bdpb\ghklb jZ\gh
ijbgZ^e_`bl lj_lv_fm khklZ\m ihwlhfm hilbfZevguc
\y`ms_]h kh^_j`bl aheu

LZ[ebp±ZJ_amevlZlu bkiulZgby [_lhgZ

‹ khklZ\Z [_lhgZ	Kh^_j`Zgaheu\ kf_rZgghf \y`ms_	JZkoh^ fZe_hl\bgZ³ [_lhgZ d]					ijhqghklv ijhiZjb\Zgby \ kml FIZ	<h^h\y`msbc < P AM	D_W
		p_f_g	aheZ	s_[_g	i_kho	\h^Z			
0*	-	330	-	1250	600	200	30,1	0,606	0,091
1	12	290	40	1250	600	202	29,6	0,612	0,102
2	25	248	82	1250	600	204	26,8	0,618	0,108
3	37	208	122	1250	600	206	23,5	0,624	0,113
4	50	165	165	1250	600	208	17,0	0,630	0,103

Ijbf_qZgh0* - bkoh^ghkfZ_ [_lhgZ ah\ukhklZ\

<uqbkeyxl jZaghklv jZkoh^Z p_f_glZ ûP \ bkoh^
\ khklZ_ k hilbfZevghf dhebq_kl\hf kf_rZgghf \y`m

ûP [PP‹ = 330- d]

AZl_f jZkkqblu\Z_f jZkoh^ p_f_glZ aheu b i_kdZ
GZ i_j\uc aZf_k

$$Ц_1 = Ц_N + \frac{\Delta Ц}{3} = 208 + \frac{122}{3}$$ d]

$$m'_{зу} = \frac{Ц_1 * 3У^{опт}}{100 - 3У^{опт}} = \frac{249*37}{100-37}$$ d]

l_1 Ł¨l = $П - \left(\frac{Ц_1}{\rho_0^{ц}} + \frac{m'_{зу}}{\rho_0^{зу}} - \frac{Ц_б}{\rho_0^{ц}}\right) * \rho_0^{п}$ = 600 - $\left(\frac{249}{3,1} + \frac{146}{2,14} - \frac{330}{3,1}\right) * 2,64$ = d]

GZ \lhjhc aZf_k

$$Ц_2 = Ц_N + \frac{2\Delta Ц}{3} = 208 + \frac{2 * 122}{3} = 289 \text{ кг}$$

$$m''_{зу} = \frac{Ц_2 * 3У^{опт}}{100 - 3У^{опт}} = \frac{289*37}{100-37}$$ d]

l_2 l - ΔП´´ = l - $\left(\frac{Ц_2}{\rho_0^{ц}} + \frac{m'_{зу}}{\rho_0^{зу}} - \frac{Ц_б}{\rho_0^{ц}}\right) * \rho_0^{п}$ = 600 - $\left(\frac{289}{3,1} + \frac{170}{2,14} - \frac{330}{3,1}\right) * 2,64$ = 425 d]

< jZkq_l_ ijbgylu agZq_gby iehlghkl_3c dh_ffi_hgl_g $\rho_0^{ц} = 3,1$; i_kdbZ $\rho_0^{п} = 2,64$; ahemghdkZ $\rho_0^{зу} = 2,14$.

J_amevlZlu bkiulZgby aZl_j^_\rbo [_lhgguo h[j \ lZ[ebp_

LZ[ebp_ZJ_amevlZlu bkiulZgby [_lhgZ

KhklZ\	JZkoh^ fZl_jbZe3[\lhgZ f d]					<h^h\y`ms nZdlhj P AM v	ljhqghklv ihke_ijhiZjb\Zg \`\hajZkl_ kml FIZ
	p_f_g	aheZ	s_[_g\	i_khd	\h^Z		
^hi	249	146	1250	489	214	0,54	27,9
^hi	289	170	1250	425	220	0,48	31,4

DZd ke_^m_l ba j_amevlZlh\ ij_^klZ\e_gguo \ l kl_i_gb aZ^Zgghc ijhqghklb [_lhgZ fZjdb

^hihegbl_evguc khklZ\w[_hfhjhZ^[hGZkhklZ\Z [_lhgZ fh
aZ_jr_g

Kibkhd bkihevah\Zgguo bklhqgbdh\

1 LmjqZgbgh\ K<jhB l_evgu_ fZl_jbZeu ba l_ogh]_
>We_dljhgguc j_mkqmjkgd_ /h<khB[b_LmjqZgbgh\ ±
k

J_dhf_g^Zpbb ih ijbf_g_gbx \ [_lhgZo aheu re
kf_kb l_ieh\uo we_dljhklZgjFbKljhGBaB^@Zl ± k