

MUSC4104

5 Xj UbWYX Gh X]Yg]b A i g]W<]ghcfm/ 7 i h fY &



7ci fgY⁻Cj Yfj]Yk

GHJZ7cbHJWh8YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWJhjcb	D\cbY
8f'>c\b'BUd]Yf	<u>*bUd]Yf4 i bgk "YXi "Ui</u>	H\i fgXUm&!(cf VmUddc]bha Ybh	Fcca '%% KYVghYf @YjY``%	-',) '*-)'

@YWhi fYfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWJhjcb	D\cbY
8f'9``Yb' <ccdyf< td=""><td>gUa 4 i bgk "YXi "Ui</td><td>H65</td><td>b#U</td><td>H65</td></ccdyf<>	gUa 4 i bgk "YXi "Ui	H65	b#U	H65

GWXcc`7cbHJWhi±bZcfa Uhjcb

GWXcc``cZh\Y'5fhg'UbX'AYX]U

Fcca " ‰ž@YjY`" žFcVYfhK YVghYf*6i]`X]b[fl %(Ł

D\cbY.'f\$&Ł'-',)'(,)*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. k k k "Ufhg"i bgk "YXi "Ui #gUa

5W_bck `YX[Ya YbhcZ7ci blfm

I BGK '5frgž8Yg][b'UbX'5fW,]hYWi fY'? Ybg]b[hcb'UbX'DUXX]b[hcb'WJa di gYg'UfY'Vi]'hcb'5Vcf][]bU`@UbXg"'K Y'dUmci f'fYgdYWig'hc'h\Y'6]X'][U''UbX'; UX][U''dYcd'Yg'k \c'UfY'h\Y'7i ghcX]Ubg'cZh\YgY'`UbXg" K Y'UW_bck 'YX[Y'h\Y'5Vcf][]bU`'UbX'HcffYg'GHfU]h=g`UbXYf'dYcd'Ygž'h\Y':]fgh5i ghfU`]Ubgžk \cgY'`UbXgž k]bXg'UbX'k UhYfg'k Y'U``'bck 'g\UfYž'UbX'dUmfYgdYWihc'h\Y]f'i b]ei Y'j U'i Ygž'UbX'h\Y]f'Wcbh]bi]b['UbX YbXi f]b['W 'h fYg'k \]W. 'XYYdYb'UbX'Ybf]W. 'h\Y'`]ZY'cZci f'bUh]cb'UbX'Wca a i b]h]Yg"''

 $\label{eq:continuous} \text{$\overset{\cdot\cdot}{=}$ U[Y'WciftY'gmcZthY'CZthY'Dfc'J]WY!7\lubW'``cf'+bX][Ybcig']$ $$BGK_f_b'+bX][Ybcig'ghtUhY[m]$ $$BGK_f'+bX][Ybcig'ghtUhY[m]$ $$BGK_f'+bX][Ybcig'ghtUhY[m]$ $$BGK_f'+bX][Ybcig'ghtUhY[m]$ $$BGK_f'+bX][Ybcig'ghtUhY[m]$ $$BGK$

7ci fgY 8YHJ] g

I b]hg cZ7fYX]h**

Gi a a UfmcZh\Y 7ci fgY

 $: cW gg]b[\ 'cb'5i \ ghfU`]Ub'a \ i \ g]Wz]b'5Xj \ UbWXXGh \ X]Yg']b'A \ i \ g]W<\]ghcfm/\ '7 \ i \ 'h \ fY'\&'mci \ 'k \]``Udd`m \ _bck \ 'YX[\ Y'UbX'g_]``g'XYj \ Y`cdYX']b'Y`YWhj \ Ygz'WcfY'Wci \ fgYgz'UbX'gdYW]U`]gUh]cb'gdYW]Z]Wwci \ fgYgz']b \ gi \ ghU]bYX'Yb[\ U[\ Ya \ Ybhk \]h\ 'U'g]b[\ 'Y'dfc'YWhfYggUmz'fYdcfhz'dc']WhXcW \ a \ Ybhz'dYfZcfa \ UbWY'cf$

H\Y`UggYgga Ybhg`gi ddcfhih\YgY`ZcWjž'UbX`dfcj]XY`cddcfhi b]hm`Zcf`dYYf`[i]XUbW'ž`]b`UXX]hjcb`hc`[i]XUbW' UbX`ZYYXVUW_`Zfca `h\Y`Wci fgY``YWhi fYf"`H\Y`gYa]bUf`Zcfa Uhi\Ug`VYYb`W\cgYb`hc`cdhja]gY`ZYI]V]`]hm`cZ hYUW\]b[`UbX``YUfb]b[`dfcWyggYg"

5ggYgga Ybh

 \blacksquare '588 \blacksquare \blacksquare B ž'MC I 'A I GH'DF 9G9BH'5 'HC D=7 'DF C DC G5@'\B' 'H< 9'K 99?'' 'G9A\B5F'''H\ci [\'bc a Uf_g'UfY'Ugg][bYX'X]fYWfmhc'h\Y'hcd]WdfcdcgU'ž'ZU]'i fY 'hc'gi Va]h']hk]\''fYgi 'h']b''UhY'dYbU'h]Yg'VY]b[Udd']YX'hc'h\Y'5bbc'H\YX'6]\'\]c[fUd\m''

5ggYgga Ybh& DfYgYbhJh]cb

5ggYgga Ybh``Yb[h\. '%\$'!'%) 'a]bi hYg'dfYgYbhUh]cbž'%\$!%) 'a]bi hYg'X]gW gg]cb 8i Y'XUhY. 'K YY_g'+'hc''%\$']b'WUgg

 $8 fuZndfYgYbhUh]cb" \cdot 9 UWX \cdot gh XYbhk]^{```[\]j Y \cdot U \cdot gYa \]bUf \cdot dfYgYbhUh]cbg \cdot cZU \cdot XfUZncZhXY]f \cdot dfc \cdot YWh' \cdot 5 \cdot k f]hhYb i Yfg]cb \cdot k]^{```U \cdot gc \cdot VY \cdot gi Va]hhYX"$

a a YX]UHY`]b!WUgg`ZYYXZcfk UfX#ZYXVUW_ž'UbX`bcHyg`cb`gi Va]HYX`j Yfg]cb"

5XX]h]cbU`XYhU]`g

9UW. 'ghi XYbhk]``[]j Y'U'dfYgYbhUhjcb'ci h]b]b['h\Y]f'dfc YWhfbggYgga YbhHUg_'' Ł'Ug'U'k cf_']b'dfc[fYgg UbX'dUfhjWjdUhY']b'h\Y'X]gW gg]cb'cZh\Y]f'k cf_"'DfYgYbhUhjcbg'k]``'hU_Y'd'UWY']b'k YY_g'+'!'%\$"'@Yb[h\z'%\$'!%) 'a]bi hYg'Zcfa Ybhcf''YX'X]gW gg]cb'f5ggYgga YbhHUg_'(Ł''5 k f]hhYb'j Yfg]cb'cZh\Y dfYgYbhUhjcb'a i ghVY'gi Va]hhYx'hc'A ccX'Y'Vm) da 'cb'h\Y'A cbXUmVYZcfY'h\Y'dfYgYbhUhjcb']g'[]j Yb"'H\]g j Yfg]cb'a UmVY']b'dc]bhZcfa 'UbX'a Umi gY'Dck Yfdc]bhg`]XYg'': cf'gh XYbhg'i bXYffU_]b['h\Y'dYfZcfa UbW'cf'Wca dcg]h]cb'cdhJcbz'mci f'dfYgYbhUhjcb'g\ci 'X']bWi XY'Vch\'gca Y'Yl d'UbUhcfma UhYf]U`'UbX'U'j]XYc'cZ dUfhcZmci f'dYfZcfa UbW'cf'UfYwcfX]b['cZdUfhcZmci f'Wca dcg]h]cb'Zcf'XYa cbghfUhjcb''=ZYUg]V'Yž'h\Y dYfZcfa UbW''a UmVY'dfYgYbhYX'`]j Y']b'h\Y'WUgg''H\Y'Yl d'UbUhcfma UhYf]U''a i ghVY'gi Va]hhYx'hc'A ccX'Y Vm) da 'cb'h\Y'A cbXUmVYZcfY'h\Y'dfYgYbhUhjcb']g'[]j Yb''

5ggYgga Ybh' . Dfc YWh

5ggYgga Ybh`Yb[h\.'\$\$\$ k cfXg

Gi Va]gg]cbˈbch/g. ˈH\]gʻUgg][ba Ybh]gʻXi YʻVm'%) - ˈDA ˈcbˈh\YʻHi YgXUmcZh\Yʻk YY_ʻZc``ck]b[ˈmci f dfYgYbhJh]cb"·H\i gž']Zmci ˈdfYgYbhJbˈk YY_ʻ, žˈmci fʻUgg][ba Ybhk]``'VYʻXi Yʻcbʻh\YʻHi YgXUmcZk YY_ʻ- 'Vm %%) - 'DA "

9ggUmcb gY ZgY YWYX hcd W! "\$\$\$ k cfXg":]bU UggYgga YbhHJg_"

9ggUmg k]``VY a Uf_YX UbX fYh fbYX k]h\ ZYYXVUW_

H\]g]g bchU Hi fb]h]b Ugg][ba Ybh

5XX]h]cbU`XYhJ]`g

Ghi XYbhgʻa UmXYj]gYžfYgYUfW\ 'UbX'dfYgYbhiUb'YggUmh\UhYI d`cfYgʻcbY'cfʻa cfY'_Ym]XYUgʻ]bʻfY`Uh]cbʻhc 5i ghfU`]Ubʻa i g]WʻHcd]Wgʻk]``'UʻgcʻXfUk 'cbʻh\Y'X]gW gg]cbgʻ]bʻk YY_gʻ%—`&'UbX'fY`UhYʻhcʻh\Y'Zci fʻgYa]bUf h\Ya Ygʻ[]j Ybʻ]bʻk YY_gʻ%—`(.'a i `h]W`hi fU`'5i ghfU`]Uža i g]WcZh\Y'UWUXYa]WhfUX]h]cbža i g]WcZ \\
\DX][Ybci gʻ5i ghfU`]UbgžʻUnn'UbX\(\text{cf'dcdi 'Uf'a i g]W}bʻ5i ghf'U]U"

5 Nyfbuhj Y mž Ug dYf N Y Wci fgY XYgWfdhlcbž ghi XYbhg a Umgi Vghhi NY Ubch Yf Nug_ Zcf N Y YggUm'

.

DYfZcfa UbWY cZU k cf_cfk cf_gcZ5i glfU`]Ub a i g]W 6Ykk YYb '& 'UbX 'W) a]bi laygcZXi fUljcbžfYWcfXYX Vmj]XYc 'UbX 'UWW gg]V Y Zcfj]Yk]b['UbX 'UggYgga YbhZcf'Vch\ 'h\Y ']b! WUgg 'dfYgYblUljcb 'UbX 'h\Y 'Z]bU` dfcXi Wljcb" + Ubmj]XYcž'h\Y \UbXg 'UbX 'ZJWY cZh\Y 'gh XYbhhc 'VY 'UggYggYX'a i ghVY'j]g]V Y 'UhU` 'ia Yg" H\Y 'Z]bU` j]XYc 'gi Va]gg]cb a i ghU`gc 'VY 'UWWca dUb]YX 'Vml\Y 'gi Va]gg]cb cZU') \$\$ 'k cfX 'X]gW gg]cb cZh\Y k cf_fgŁ'h\UhUXXfYggYg 'h\Y]f'dcg]hjcb 'Ug'YI Ya d`Ufg cZ5i glfU`]Ub a i g]W 'H\]g 'dcg]hjcb]b['g\ci `X'VY WcbhYI hi U`]qYX 'k]h\ 'Zcfa U``fYZYfYbWg'hc 'k f]hjb[g'Uvci h5i glfU`]Ub a i g]WYhW'

•

7 ca dcg]h]cb cZZ]j Y hc g]l a]bi hYg Xi fUh]cb zdfYgYbhYX Ug `U gWcfY `Ub X Ug `Ub a d' `fYWcfX]b[`f]h]g bch YggYbh]U` hc i gY '\i a Ub' dYfZcfa Yfg Zcf h\Y fYWcfX]b[Ł'H\Y gi Va]gg]cb a i ghU`gc `VY `UWWca dUb]YX `Vmh\Y gi Va]gg]cb cZU`) \$\$ k cfX X]gW gg]cb cZh\Y k cf_fgŁh\UhUXXfYggYg h\Y]f dcg]h]cb `Ug YI Ya d`Ufg cZ 5 i ghfU`]Ub a i g]W` H\]g dcg]h]cb]b[`g\ci `X `VY `WcbhYI h U`]gYX k]h\ Zcfa U` fYZ/fYbWfg hc k f]h]b[g`UVci h 5 i ghfU`]Ub a i g]WYhW'

 $\pm 0.1 \text{ h, Y WJgY cZdYfZcfa UbWYg'UbX'Wca dcg]h]cbgž'h, Y 'hcd]WdfcdcgU'`a i gh'U`gc'ci h]bY'U''th, Ya Y''h, Uh`]b_g mci f'dfcdcgYX'k cf_'hc'h, Ya Yg'cZ5i ghfU`]Ub'a i g]WYhW''$

5" \$\$\$"k cfX"fYdcfhcb"Ub"UgdYWhcZ5i ghfU`]Ub"a i g]W"5"fYdcfh]g"X]ZZYfYbhZca "Ub"YggUm]b"h\Uh]hXcYg bchbYYX"hc"XYj Y`cd"U`cb["h\Y"]XYUg"cZUb"Uf[i a Ybhk]h\"U\mdch\Yg]g""#i\Wb"Xc"gc"fZcf"YI Ua d`Yž"H\]g fYdcfhg\ck g"h\Uh7 i h fU`mUbX"@b[i]gh]\W\"m8]j YfgY"g\W.cc"gh XYbhg"VYbYZ]hZca "Yb\\chi bhYf]b["a i g]\W cZh\Y]f"ck b VU_[fci bXg"]b"h\Y"\W\\ggfcca "\text{

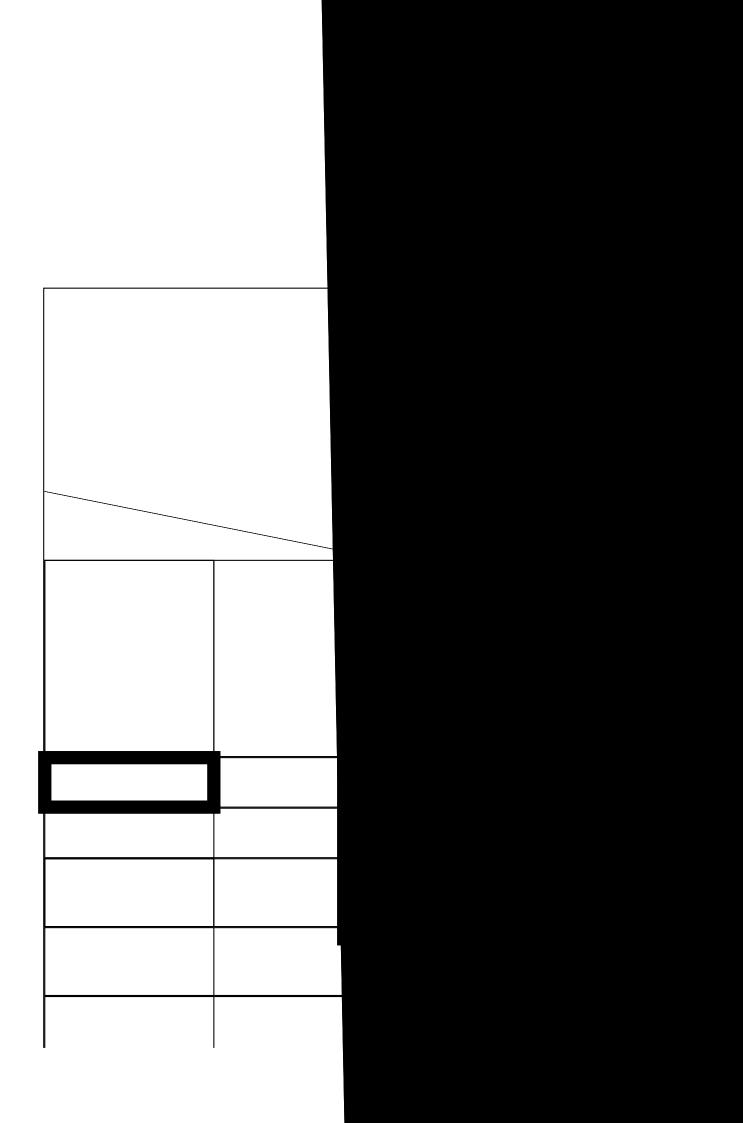
Ghi XYbhgʻbYYXʻhcʻgi Va]h'Uʻhcd]WdfcdcgUʻj]UʻA ccX`YʻVYZcfYʻh\YʻWUggʻ]bʻk YY_ʻʻ "'H\YgY`k]``h\YbʻVY X]gW ggYXʻ]bʻWUggʻ]bʻk YY_ʻʻ žʻUbXʻfYj]Yk YXʻVmh\Yʻ7 cbj YbcfžʻUbXʻUddfcj YXʻ—'UZhYfʻa cX]Z]WUh]cbʻ]Z bYWfggUfm'ʻ±ik]``VYʻdcgg]V`YʻhcʻfYZ]bYʻh\Yʻhcd]WcfʻW\Ub[Yʻmci fʻhcd]WVi hʻUbmW\Ub[Ygʻk]``bYYXʻhcʻVY Uddfcj YX`UbXʻh\YʻUbbchUhYX`V]V`]c[fUd\mk]``gh]```VY`Xi Yʻcbʻ, h\`C WcVYf"

5ggYgga Ybh(. A Ybhcf]b[

Zcf'ghi XYbhdfYgYbhUhjcbg"'6ch\ 'Wca dcbYbhg'fYei]fY'ch\Yf'ghi XYbhg'hc'UWWgg'h\Y'V]V`]c[fUd\mih\Uhimci dfYdUfY'Zcf'5ggYgga Ybh'HUg_'%"'

9UW. 'ghi XYbhifth.Y'a YbhYYE'\UgʻVYYbʻUgg][bYX'Uʻghi XYbha Ybhcf"'5 'ghi XYbhK =@BCH'VY'h\Y]f'a Ybhcf'g a Ybhcf"'H\i gʻYUW. 'ghi XYbhk]```VY`cb['hc'tk c'dU]fgž'cbY'UgʻUʻa Ybhcf'UbX'cbY'UgʻUʻa YbhYY"'H\YgY'UfY cf[Ub]gYX'Ugʻ[fci dgʻ]bʻA ccX'Y"'H\Y'[fci d'k]```\Uj Y'h\Y'Zc``ck]b['bUa Y'ghfi Whi fY. 'A YbhYY'B5A 9ž A Ybhcf'B5A 9"'

H\Y'UggYggUV'Y'fYei]fYa Ybhg'cZh\Y'a Ybhcf!a YbhYY'fY`Uh]cbg\]d"'



FYgci fWfg

FYWca a YbXYX FYgci fWfg

 $Gh XYbhg g ci `X'Wbgi `hh\Y'fYUX]b[``]ghdfcj]XYX'h\fci [\ `@Y[Ubhc `]b'h\Y'A ccX`Y'g]hYž'UbX']ZbYYX'VYž fYUWei U]bhh\Ya gY`j Yg'k]h\'h\Y'XUhUVUgYg'F = A'UbX'H\Y'A i g]W+bXYI "$

7ci fgY '9j U'i Uh]cb 'UbX '8Yj Y'cda Ybh

 $\label{thm:continuous} H\Y'WcifgY'k]```VY'Yj U`i UhYX'h\fci [\'A m9I dYf]YbWY'WcifgY'Yj U`i Uh]cb"'H\ci [\'h\]g'WcifgY']b'`dfYj]ci g]hYfUh]cbg'k Ug'dcg]h]j Y`mfYj]Yk YXž']hg'WcbhYbh'\Ug'VYYb'Zcfa U`]gYX']b'``]bY'k]h\'ZfYei Ybh'ZYYXVUW_'h\Uh'U WcifgY']b'5i ghfU`]Ub'a i g]Wk ci `X'VY'U'dcg]h]j Y'UXX]h]c$

\

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

Hi fb]h]b Gi Va]gg]cb

Image: Ybwci bhYf'U'dfcV'Ya k \Yb'UhYa dhjb['hc'gi Va]hmci f'Ugg][ba Ybhh\fci [\'Hi fb]h]bz'd'YUgY

HY'Yd\cbY'9| hYfbU''Gi ddcfhcb'-',) "''' %cf'Ya U]''h\Ya 'cb'Y! hYfbU'hY'hgi ddcfh4 i bgk "YXi "Ui ""Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY_YbXg'fl *) 'XUmg'U'mYUft'''=\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ub'Y! hYbg]cb\mathred{Image: Wa Jhmci h\Yf'f'Y'j UbhXcW a Ybhg\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k]'`

JbWi XY'Ug'Yj]XYbW' hc'gi ddcfhmci f'Y! hYbg]cb'Udd']\wUh]cb"'\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k]'`

Ui hca Uh]\wU'`mfYW']j Y'U'h]\w_Yhbi a VYf\mathred{Image: hY'Yd\cbY'mci 'k]\tag{Y}\wu''mug_'\mathred{Image: Wa'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY}\wu''mug_'\mathred{Image: hY'Yd\cbY''mci 'k]\tag{Y}\wu''mug_'\mathred{Image: hY'\mathred{Image: hY'\mathred{I

; YbYfU``mž'UggYgga YbhiHug_g'a i ghVY'gi Va]hhYX'Y`YVWfcb]\W)``mij]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ba Ybh'' =b']bgHJb\W'g'k \YfY'h\]g']g'bchdcgg]V`Yž']hk]```VY'gHJhYX'cb'mci f'\\circ i fgY'g'A ccX`Y'g]hY'k]h\U`hYfbUhjj Y'gi Va]gg]cb'XYHJ]`g''

cfi]bZcfa Uhjcbicbi\ckihcigi Va]hUgg][ba Ybhgicbi]bYij]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va]hUgg][ba Ybha ccXiY

5 WUXYa]W<cbYglmUbX D`U[]Uf]ga

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i±i\WbihU_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiW\YUh]b[ihciU\W]XYbhU`m\Wcdm]b[iZfca iUigci f\Wik]h\ci hiU\w_bck iYX[Ya Ybh'

I BGK '[fci dg'd'U[]Uf]ga ']bhc'h\Y'Zc``ck]b['WUhY[cf]Yg.

7 cdm]b[. I g]b['h\Y'gUa Y'cf'j Yfmg]a]'Uf'k cfXg'hc'h\Y'cf][]bU``h\I hcf']XYU'k]h\ci h'U\W_bck `YX[]b['h\Y gci f\W'cf'i g]b['ei chUh]cb'a Uf_g"'H\]g']b\W XYg'\\cdm]b['a Uh\Yf]U`gz']XYUg'cf'\\cb\W'dhg'\overline{T}ca 'U'\Vcc_z'Ufh]\W\Z f\Vdcfhcf'ch\Yf'k f]hh\'b 'Xc\W a Ybhz'df\YgYbhUh]cbz'\\cdot a dcg]h]cbz'\Ufrk cf_z'\X\Yg][bz'\Xf\Uk]b[z'\W]f\W]hfmz'\\cdot a di h\'f dfc[f\Ua 'cf'gc\Ik \Uf\Z'k \Y\Yg]h\'z']b\Yf\Yf\Yf\YY\\f\Cb]\Wf\Ygci f\W'z'cf'\Ubch\Yf'\d\Yfgcbfg'\Ugg][ba Ybhk]h\ci h\Uddfcdf]\Uh\'\U\W_bck `YX[Ya Ybh''

₺Uddfcdf]UhY 'dUfUd\fUg]b[.'

5WUXYa]W±bZcfa Uh]cb

8 i Y'hc'Yj c'j]b['UXj]WY'VmBGK '<YU'h\ž'ghi XYbhg'a i gh\W\Y_'Zcf'i dXUh\Y\']bZcfa Uh]cb'fY[UfX]b['cb`]bY 'YUfb]b['Zcf'U``'5fhgž'8Yg][b'UbX'5f\W]h\Y\Mi fY'\\chi fgYg'h\]g'h\fa 'fJ]U'A ccX'Y'cf'\\chi fgY']bZcfa Uh]cb dfcj]XYX"Ł

: cf YggYbhJU gh XYbh]bZcfa UhJcb fY UhJb[hc.

- fYei Yghg 'Zcf'Yl hYbg]cb/
- `UhY`gi Va]gg]cbg`[i]XY`]bYg/
- fYj]Yk cZa Uf_g/
- I BGK '< YU`h\ 'UbX'GUZYhm'dc`]W[Yq/
- YI Ua]bUhcb dfcWXi fYg/
- gdYWJU``Wcbg]XYfUhjcb`]b`h\Y`Yj YbhcZ]``bYgg`cf`a]gUXj Ybh fY/
- gh XYbhYei]mUbX X]gUV]`]m/
- UbX'ch\Yf'YggYbhJU`'UWUXYa]W]bZcfa UhJcbž'gYY