

MUSC1603

A UhYf]U`g`UbX`Ghfi Whi fYg`cZA i g]W&

GYa YghYf'Hk c''#'&\$%

7ci fgY Cj Yfj]Yk

GHJZZ7cbHJWh8YHJ]`g`

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`] m	@cWUh]cb	D\cbY
>c\b'DYhYfgcb	u u	‰"\$\$da!%"\$\$da	CZZJWY**%\$)ž @YjY`*%ž FcVYfh KYVghYf*6`X[-',)`(,+\$

"@YWhifYfg"

B Ua Y	9a U]`	5j U]`UV]`]hm	@cWUh]cb	D\cbY
< Uff]gcb '7 c`]bg	\"Wc``]bg4 i bgk "YXi "Ui	<uff]gcb^g\ci^x WcbHJWYX^j]U^Ya U]`"</uff]gcb^g\ci^x 		

'Hi hcfg'

BUa Y	9a U]`	5j U]`UV]`]lm	@cWUhjcb	D\cbY
8Uj]X'HUmcf		8Uj]X'g\ci`X'VY WcbHUWYX'j]U'YaU]`. XUj]X"UbH\cbm'HUmcf 4[aU]`"Wca		
GHYj Yb A UWXUa Yf		GhYj Yb'g\ci `X'VY WcbhUWYX'j]U'Ya U]`. ga UW\$&4 cdhi gbYh' Wca "Ui		

GW.cc`7cbHJWh =bZcfa Uhlcb

Fcca " &ž`Yj Y`" FcVYfhK YVghYf'6i]`X]b[

D\cbY. f\$&Ł'-',) '(,) *

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

K YVq]hY. '\hda.##qUa "Ufhq"i bak "YXi "Ui

 $\label{eq:hamiltonian} $$HY'GW.cc``cZh,Y'5ftg'UbX'AYX]U'k ci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck``YX[Y'th,Y'HfUX]tjcbU``7i gtcX]Ubg\cong hY'6YXY[U'`fPYbg]b[tcb'WJa di g\cong \cong \cong mUbX'5fti/'8Yg][b'7Ua di gYg\cong \cong \cong$

5 hmy b X Ub WY F Yei] f Ya Yb hg

5 'ghi XYbhi]g'Yl dYWYX'hc'UhrYbX'U```WUgg'WebhUWi\ci fg'Zcf'U'ZUWY!hc!ZUWY'fl &: Ł'cf'V`YbXYX'Wei fgY'UbX Wea d'YhY'U```UWIjj]hjYg'Zcf'U'VYbXYX'cf'Z ``mcb`]bY'Wei fgY"

5 'ghi XYbhik \c'Uff]j Ygʻa cfYʻh\Ubʻ%) 'a]bi hYgʻ`UhYʻa UmVYʻdYbU`]gYX Zcfʻbcb!UhhYbXUbW/" =Zgi W\'U'dYbU`hm

]g`]a dcgYXž'h\Y`ghi XYbha i ghiVY`]bZcfa YX`j YfVU``mUhih\Y`YbX`cZWUgg`UbX`UXj]gYX`]b`k f]h]b['k]h\]b`&(\ci fg"

ZUgh XYbhYl dYf]YbWg¹]`bYggža]gUXj Ybh fY`cf`ch\Yf`cWW ffYbW h\Una U_Yg`UVgYbW 'Zca 'U WUgg#UW]j]lmi bUj c]XUV`Yž'cf`Yl dYWg`hc`VY`UVgYbhZca 'U`Zcfh\Wa]b['WUgg#UW]j]lmi h\Ymg\ci `X`gYY_ dYfa]gg]cb`Zca 'h\Y`7 ci fgY`5i h\cf]lmi`UbX`k \YfY`Udd`]WUV`Yž'h\Y]f`fYei Yghg\ci `X`VY`UW\a dUb]YX`VmUb cf][]bU``cf`Wff]ZYX`WcdmcZU`a YX]WU``WYff]ZWUhY`cf`ch\Yf`Zcfa 'cZUddfcdf]UhY`Yj]XYbW\"

5 '7 ci fgY '5 i h\cf]hma UmYI W gY 'U'ghi XYbhZica 'WUggYg'cf'UWfj]hJYg'Zcf'i d'hc'cbY'a cbh\"'< ck Yj Yfz'h\Ym a UmUgg][b'UXX]hJcbU``UbX#cf'U'hYfbUhJ Y'hUg_g'hc'Ybgi fY 'Wca d`]UbW\"'5 '7 ci fgY '5 i h\cf]hmWcbg]XYf]b['th\Y [fUbhJb['cZUVgYbW'a i ghVY'gUhJgZ]YX'U'ghi XYbhk]```ghJ```VY'UV'Y'hc'a YYhh\Y'Wci fgY'g'`YUfb]b['ci hWca Yg UbX#cf'j c'i a Y'cZ`YUfb]b["'5 'ghi XYbhgYY_]b['Uddfcj U``hc'VY'UVgYbhZcf'a cfY'h\Ub'cbY'a cbh\'a i ghUdd`m]b'k f]hJb['hc'h\Y'8 YUb'UbX'dfcj]XY'U``cf][]bU``cf'Wff]Z]YX'gi ddcff]b['XcW a YbhUhJcb"

: cf'a cfY`]bZcfa Uhjcb`UVci hih\Y`UthYbXUbWY`dfchcWc`g`]b`h\Y`: UW\`hmcZ5fhg`UbX`GcWjU` GWjYbWYg.`<u>\hdg.#k k k "Ufhg"i bgk "YXi "Ui #W ffYbHghi XYbhg#UWUXYa]W]bZcfa Uhjcb#dfchcWc`g![i]XY`]bYg#</u>

5 WUXYa]W = b Zcfa Uh]cb

: cf`YggYbh]U``ghi XYbh`]bZcfa Uh]cb`fY`Uh]b['hc. 'fYei Yghg`Zcf`Yl hYbg]cb/fYj]Yk 'cZa Uf_g/cWW dUh]cbU``\YU`h\UbX`gUZ/hm/Yl Ua]bUh]cb'dfcWYxi fYg/gdYW]U``Wcbg]XYfUh]cb`]b'h\Y'Yj YbhcZ]``bYgg`cf`a]gUXj Ybhi fY/ghi XYbhYei]hmUbX`X]gUV]`]hm/UbX`ch\Yf`YggYbh]U``UWUXYa]W]bZcfa Uh]cbž qYY`\hdg.#k k k "Ufhq"i bak "YXi "Ui #W ffYbhqhi XYbhq#UWUXYa]W]bZcfa Uh]cb#dfchcWc`a![i]XY`]bYq#

7ci fgY 8YHJ] g

7 fYX]hDc]bhg *

Gi a a UfmcZh\Y 7ci fgY

Gi VYWh5fYU. ? ge[U

H\]g`WcfY`Wci fgY`YI hYbXg`mci f`Zci bXUh]cbU``_bck `YX[Y`cZh\Y`a UhYf]U`gžghfi Wi fYg`UbX`dfcWiggYg`cZ hcbU``a i g]WUbX`cZh\Y`Udd`]WUh]cb`cZ\Ufa cb]WUbX`a Y`cX]WdfUW]Wg`]b`dcghl% \$\$`Wca dcg]h]cb`UbX`ch\Yf ghmYg`]bWi X]b[`dcdi `Uf`a i g]WUbX`d\nn"'Mci `k]``XYj Y`cd'hYW\b]WU`_bck `YX[Y`UbX`g_]``]b`h\Y`UbU`mg]g UbX`Udd`]WUh]cb`cZa Y`cX]WUbX`\Ufa cb]WY`UVcfUh]cbžj c]W!`YUX]b[`ž'UbX`a i g]WU``Zcfa "'9I YfW]gYg`]b Wca dcg]h]cbU``WfUZhdfcj]XY`h\Y`mci `k]h\`h\Y`cddcfhi b]mhc`XYa cbghfUhY`]b]h]Uh]j Y`UbX`WfYUh]j]hm'rH\Y Wci fgY`XYj Y`cdg`WcfY`g_]``g`]b`a i g]WU`dd`h\Y`UV]`]hmhc`Udd`mh\YgY`]b`ch\Yf`UfYUg`cZa i g]WU`dfUW]WY`UbX`fYgYUfW\"`F\mh\a `k cf_g\cdg`k]``YbUV`Y`mci `hc`Z fh\Yf`XYj Y`cd`mci f`Ui fU``g_]``g`h\fci [\`h\Y dYfWdh]cb`UbX`YI YW`h]cb`cZf\mh\a]WU``mWca d`YI 'a i g]W

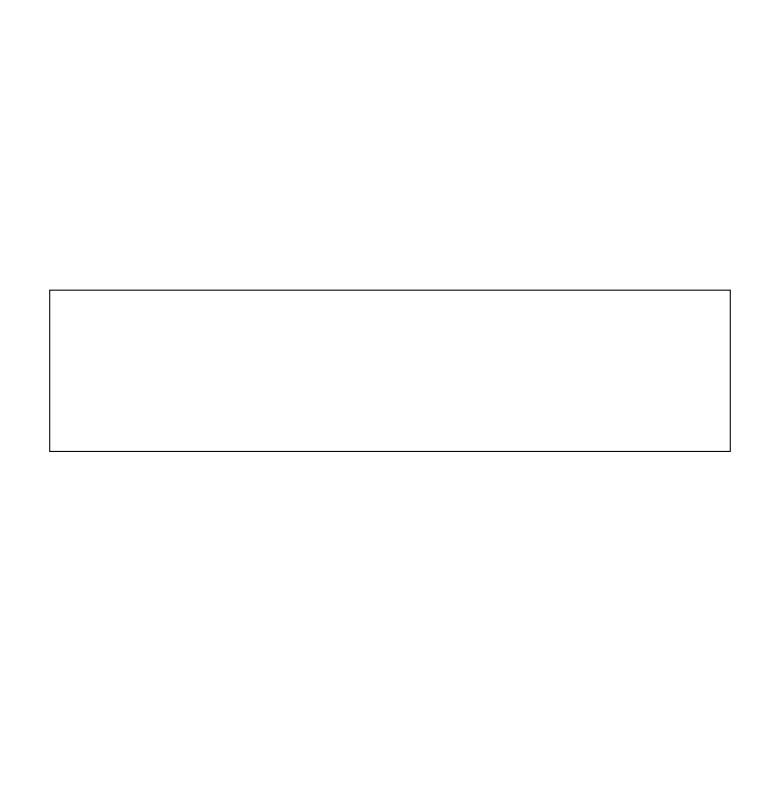
5 hh Y WcbWi g]cb cZh]g Wci fgY h Y gh XYbhk] ` VY UV Y hc

- %" a UghYf`_bck`YX[Y`cb`h\Y`a UhYf]U`gžghfi WhifYg`UbX`dfcW/ggYg`cZhcbU``a i g]WVYmcbX`h\Y Zci bXUh]cbU```Yj Y`
- &" UbU`mgY`X]Uhcb]Wa Y`cXmž`\Ufa cbmiUbX`Zcfa `]b`dcgH% \$\$`a gi]WU``ghm`Yg`]bWi X]b[`dcdi `Uf`a i g]W UbX`^Unn`
- ' " Udd`m_bck `YX[Y`UbX`g_]``g`]b`a Y`cX]WUbX`\Ufa cb]WY`UVcfUh]cbžj c]WY!`YUX]b[ž'UbX`a i g]WZcfa]b`dcgh'% \$\$`a i g]WU``ghmY`hc`WcfY`k cf_g
- ("Udd`mih\Y]f`XYj Y`cd]b['a i g]WU``_bck `YX[Y`UbX`g_]```hc 'a i g]Wa U_]b[ž'k \Yh\Yf`]hVY`dYfZcfa]b['cf Wca dcg]b[
-) "XYa cbghfUhY`WcfY`g_]`g`]b`a i g]WJUbg\]dž`]b`dUfh]W``Ufža i g]W`]hYfUWhzgWcfY`fYUX]b[ž`UbX`h\Y YI YW hcb`cZWca d`YI `f\mh\a]Wghfi Whi fYg`

HYUWX]b['GhfUhY[]Yg'

6A i gʻUbXʻ65ʻgh XYbhgʻUhhYbXʻUʻk YY_`micbY!\ci f``YWn fYʻcbʻa i g`JWh\Ycfm'UbX`\Ufa cbm'Uʻk YY_`micbY!\ci f`h hcf]U``VUgYXʻcbʻXYj Y`cd]b['Ui fU``g_]``g/UbXʻUʻk YY_`micbY!\ci f`f\mh\a]WhfU]b]b['k cf_g\cd"

@YWi fYg`cb`a i g]Wh\YcfmUbX`\Ufa cbmUfY`Ui [a YbhYX`k]h\ `gci bX`fYWcfX]b[gž'dck Yfdc]bhdfYgYbhUh]cbgž UbX`]b!WUgg`YI YfW]gYg`k \]W\ 'dfYdUfY`ghi XYbhg`Zcf'h\Y`Wca d`Yh]cb`cZgYhWca dcg]h]cb!UbU`mg]g Ugg][ba Ybhg"`5i fU``hi hcf]U`g`]bj c`j Y`]b!WUgg`YI YfW]gYg`Ug`k Y```Ug`Ui fU``UbU`mg]g`cZgY`YWhYX`a i g]WU`YI Ua d`Yg"`F\mh\a]WhfU]b]b['k cf_g\cdg'dfcj]XY`]bhYbg]j Y`Xf]``g`UbX`YI YfW]gYg`XYg][bYX`hc`XYj Y`cd f\mh\a]WdYfWdh]cb`UbX`YI YW h]cb"



Hi fb]hjb gYhjb[. H\]g]g bchU Hi fb]hjb Ugg][ba Ybh

5ggYgga Ybh& 5i fU`#\mh\a]WYI YfW]gY

GhUfhXUhY. Bch5dd`]WUV`Y

5XX]h]cbU`XYhJ]`g.

"51 ZU"K cf_g\cd"fHi hcf]U"EUbX"F\mh\a K cf_g\cd"fGh X]cE"&)ı

H\Y'5i fU``k cf_g\cd`\Y`dg`[Ui [Y`\ck `k Y```f\Y`ghi XYbh`\Ug`XYj Y`cdYX`f\Y]f`Ui fU``dYf\Wdh]cb`UbX Wa a UbX`cZh\Y`Zci bXUh]cbU``a i g]\W``_bck `YX[Y`f\fci [\`f\Y`Wci fgY"`Ghi XYbhg`k]```VY`[]j Yb`ZYYXVU\W_cb h\Y`dfc[fYgg`cZh\Y]f`Ui fU``XYj Y`cda Ybhi\fci [\`fYdcfhg`cb`h\Y`Zc``ck]b[`UggYa Ybhg.

%2.cbY.HfUbgWf]dhcb.Yl.YfWlgYžXi.Y.H\i fgXUm' \$.5i [i ghfK.YY *\2.5%si

&Ł'U'G][\h'G]b[]b[]'HYghžk\]W\'k]``\Y`X'Xi f]b['bcfa U`'5i fU`'K cf_g\cd'h]a Yžcb'H\i fgXUm'&)'C WcVYf fK YY_'% Łž)ı

 $\label{thm:condition} $$HY'F\m^{a} K cf_g\cd'ZcW'ggYg'cb'hY'XYj Y'cda YbhicZU'VYhhYf'i bXYfghUbX]b['cZa UbmiUgdYWg'cZf\m^{a} ']b'a i g]Wj]U'h\Y']bhYbg]j Y'Udd']WUh]cb'cZdfUWfWj'YJ YfWjgYg']b'dYfZcfa UbWYZ'f\m^{a}]WX]WfUh]cb'YJ YfWjgYgZ'UbX'h\Y'cddcfhi b]m'hc'XYj Y'cd'h\Y'g_]`g'bYYXYX'k \Yb']XYbhJZmjb['UbX'hfUbgWf]V]b['f\m^{a} ']b'gYWYX'YJ Ua d'Yg'Zfca'h\Y']hYfUhi fY'cZj Uf]ci g'a i g]WU'ghmYg''$

5ggYgga Ybh']g'VUgYX'cb'tk c'WUgg'Yl YfV]gYg'[]j Yb']b'F\mt\a 'K cf_g\cd'fghi XYbhg'k]``'VY'[]j Yb'bch]WYcbY'k YY_'VYZcfY'h\Y'UggYgga Ybh'k]``'VY'\Y'XŁź%l "

5ggYgga Ybh' . < Ufa cbmdcfh\(Z \)]c

&£`±b!7`UggʻhYghʻBc"'&ž'VUgYX`cb`a UhYf]U`gʻX]gWiggYX`]b`K YY_gʻ)!+ž`\Y`X`Xi f]b[`h\Y`bcfa U```YWi fYʻh]a Ycb`Hi YgXUm'%GYdhYa VYfʻfK YY_', Łž'%)ı /

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

Gh XYbhg UfY Yl dYWYX hc di hh\Y]f bUa Yg UbX gh XYbhbi a VYfg cb Yj YfmdU[Y cZh\Y]f Ugg][ba Ybhg"

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

#mci YbWci bhYf'U'dfcV'Ya 'k \Yb'UthYa dr]b['rc'gi Va]hmci f'Ugg][ba Ybht\fci [\'Hi fb]r]bž'd'YUgY
hY'Yd\cbY'9I hYfbU'Gi ddcfhcb'-',) '''' %cf'Ya U]''h\Ya 'cb'<u>Yl hYfbU'hY'hgi ddcfh4 i bgk "YXi "Ui"</u>"'Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY_YbXg'fl *) 'XUmg'U'mYUft\"'=\maintention
UfY'i bUV'Y'hc'gi Va]hmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\'Hi fb]h]b'mci 'a Um'Udd'm\Zcf'Ub'YI hYbg]cb\ZVi hmci
a i ghfYhJ]b'mci f'h]\W_Yhbi a VYf\Zfca '9I hYfbU''Gi ddcfhfU'cb['k]h\'Ubmch\Yf'fY'Yj UbhXcW'a Ybhgt'hc
]bWi XY'Ug'Yj]XYbW' hc'gi ddcfhmci f'Yl hYbg]cb'Udd']\WJh]cb'''\=\maintention
Uh\WJ'`mfYWY']j Y'U'h]\W_Yhbi a VYf\ZVi h]Zmci 'hY'Yd\cbY'mci 'k]``bYYX'hc'gdYW]\Z\WJ'`mUg_'Zcf'cbY''
Hi fb]h]b'U'gc'dfcj]XYg'i dXUhYg'cb'h\Y]f'gmghYa 'gfUh' g'cb'Hk]hYf"

; YbYfU`mž'UggYgga YbhitUg_g'a i ghVY'gi Va]hhYX'Y`YWfcb]WU``mj]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ba Ybh''=b']bghUbWfg'k \YfY'h\]g']g'bchdcgg]V`Yž']hk]```VY'ghUhYX'cb'mci f'Wci fgY'g'A ccX`Y'g]hY'k]h\U`hYfbUh]j Y'gi Va]gg]cb'XYhU]`g"

@UhY 5ggYgga Ybh'DYbU`h]Yg

Ghi XYbhgʻUfYʻfYgdcbg]V`YʻZcfʻh\Yʻgi Va]gg]cbʻcZUggYgga Ybhilug_gʻVmh\YʻfYei]fYXʻXUhYgʻUbXʻh]a Ygʻ' 8YdYbX]b[ˈcZh\YʻYl hYbhcZXY`Um]bʻh\Yʻgi Va]gg]cbʻcZUbʻUggYgga Ybhilug_ʻdUghih\YʻXi YʻXUhYʻUbXʻh]a Yž cbYʻcZh\YʻZc``ck]b[ʻ`UhYʻdYbUʻh]Ygʻk]```Udd`mi b`YggʻgdYVJU`'Wcbg]XYfUh]cbʻcfʻUʻV`Ub_YhYl hYbg]cbʻXi YʻhcʻU hYV\\b]WJ``ci hU[Yʻ]gʻ[fUbhYX'': cfʻh\Yʻdi fdcgYʻcZ`UhYʻdYbUʻhmWJʻW``Uh]cbžʻUʻʻXUmiʻ]gʻXYYa YXʻhcʻVYʻYUV\\&(!\ci fʻdYf]cXʻfcfʻdUfhih\YfYcZcdUghh\Yʻgh]di `UhYX`XYUX`]bYʻZcfʻgi Va]gg]cb''

• K cf_'gi Va]hhYX``Ygg'h\ Ub'%\$`XUmg'UZhYf'h\ Y`gh]di `UhYX`XYUX`]bY']g'gi VYVWhc'U`XYXi Wi]cb'cZ) i 'cZh\Y'hchU``Uk UfXUV`Y'a Uf_'Zfca 'h\Y'a Uf_'h\ Uhk ci `X'\Uj Y'VYYb'UW\]Yj YX']Zbch'Zcf'h\Y dYbU`hm'Zcf'Yj YfmXUmdUghh\Y'gh]di `UhYX`XYUX`]bY'Zcf'gi Va]gg]cb"'H\Uh]gz'U'ghi XYbhk \c'gi Va]hg Ub'Ugg][ba Ybh'k]h\ 'U'gh]di `UhYX`XYUX`]bY'cZ(.\$\$da 'cb'% 'A Um&\$%* 'Uh(.%\$da 'cb'%('A Um&\$%* k]``]bW f'U'XYXi Wi]cb'cZ%\$i "

HUq_k h U bcb dYfWbhJ[Ya Uf_

⊋h\Y'hUg_`]g'a Uf_YX'ci hcZ&) žh\Yb``UhY'gi Va]gg]cb'k]```UhtfUWhU'dYbU`hmcZU'XYXi Wf]cb'cZ%"&) 'Zfca 'h\Y a Uf 'Uk UfXYX'hc'h\Y'gh XYbh'Zcf'Yj Yfm&(!\ci f'dYf]cX'fbf'dUfhh\YfYcZd'dUghh\Y'ghdi `UhYX'XYUX`]bY"

- K cf_'gi Va]hhyX'%\$'hc'% 'XUmg'UZhYf'h\Y'gh]di `UhYX'XYUX`]bY'k]``'VY'UggYggYX'UbX'ZYYXVUW_dfcj]XYX'Vi h'U'a Uf_'cZnYfc'k]``'VY'fYWcfXYX'''=Zh\Y'k cf_'k ci `X'\Uj Y'fYWf]j YX'U'dUgg'a Uf_'Vi h'Zcf h\Y'`UhYbYgg'UbX'h\Y'k cf_']g'U'Wca di `gcfm'Wci fgY'Wca dcbYbh'f\i fX`Y'fYei]fYa Ybh'z'U'gh XYbh'k]`` VY'XYYA YX'hc'\Uj Y'a Yhh\UhfYei]fYa Ybh'
- K cf_'gi Va]hhYX`&\$`cf`a cfY`XUmg`UZhYf`h\Y`gh]di `UhYX`XYUX`]bY`k]``bchVY`UWWdhYX`Zcf UggYgga YbhUbX`k]``fYWY]j Y`bc`ZYYXVUW_ža Uf_'cf`[fUXY"'=Zh\Y`UggYgga YbhHUg__']g`U`Wca di `gcfm Wca dcbYbhcZh\Y`Wci fgY`U'ghi XYbhk]``fYWY]j Y`Ub`l bgUh]gZJJWcfm: U]`fl: Ł'[fUXY`Ug`U'fYgi `hcZ i bgUh]gZJJWcfmdYfZcfa UbWY`]b`Ub`YggYbh]U``Wca dcbYbhcZh\Y`Wci fgY"

H\]g']bZcfa Uh]cb']g'U`gc'Uj U]`UV`Y'Uh

\hdg.#k k k "Uffg"i bgk "YXi "Ui #W ffYbhgh XYbhg#UWUXYa]W]bZcfa Uhcb#dfchcWc`g![i]XY`]bYg#

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

D`U[]Uf]ga `]g`i g]b['h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b['h\Ya `Ug`mci f`ck b"'\lefi\Wb'hU_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b['hc`UVW]XYbhU`mWcdm]b['Zfca `U`gci f\W' k]h\ci hUW_bck `YX[Ya Ybh'

IBGK [fcidgdu[]Uf]ga]bhch\YZc``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`hYl h'cf']XYU'k]h\ci h'UW_bck `YX[]b['h\Y gci fW'cf'i g]b['ei chUh]cb'a Uf_g"'H\]g'U`gc'Udd`]Yg'hc']a U[Ygž'Ufh'UbX'XYg][b'dfcYWhgž'Ug'k Y``'Ug dfYgYbhUh]cbg'k\YfY'gca YcbY'dfYgYbhg'Ubch\Yf'g']XYUg'cf'k cfXg'k]h\ci h'WfYX]h'

⇒ Uddfcdf]UhY 'dUfUd\fUg]b[...7\Ub[]b['U'ZYk 'k cfXg'UbX'd\fUgYg'k \]'Y 'a cghmfYhJ]b]b['h\Y'cf][]bU` ghfi Wh fY 'UbX#cf'dfc[fYgg]cb'cZ]XYUg'cZh\Y'cf][]bU'žUbX']bZcfa Uh]cb'k]h\ci hUW_bck `YX[Ya Ybh'H\]g'U`gc Udd`]Yg']b'dfYgYbhUh]cbg'k \YfY'gca YcbY'dUfUd\fUgYg'Ubch\Yf'g']XYUg'cf'k cfXg'k]h\ci hWfYX]hUbX'hc d]YW]b['hc[Yh\Yf'ei chYg'UbX'dUfUd\fUgYg']bhc'U'bYk 'k \c`Yžk]h\ci hUddfcdf]UhY'fYZYfYbW]b["

 $7c^{i}$ g]cb. 'k cf_]b['k]th. 'cth. Yfg'Vi h'dUgg]b['c\Zth. Y'k cf_'Ug'U'dYfgcb'g']bX]j]Xi U''k cf_"'7c''i g]cb'U'gc

- i bXYfgfUbX mci f'f][\hg'UbX'fYgdcbg]V]`]hJYg'Ug'U'gh XYbhUhl BGK
- VY`Uk UfY`cZd`U[]Uf]ga ž`Wcdmf][\hz'l BGK `Gh XYbh7cXY`cZ7cbXi WhUbX`5VWWdhUV`Y`l gY`cZ I BGK `=\forall H`F Ygci f\W\g`Dc`]\m\m
- VY 'Uk UfY 'cZh\Y 'ghUbXUfXg 'cZVY\Uj]ci f'Yl dYWYX 'cZYj YfmcbY ']b 'h\Y 'l BGK 'Wca a i b]hm
- `cWUHY'qYfj |WYq'UbX']bZcfa UHcb'UVci hi BGK 'UbX'l BGK '@|VfUfm

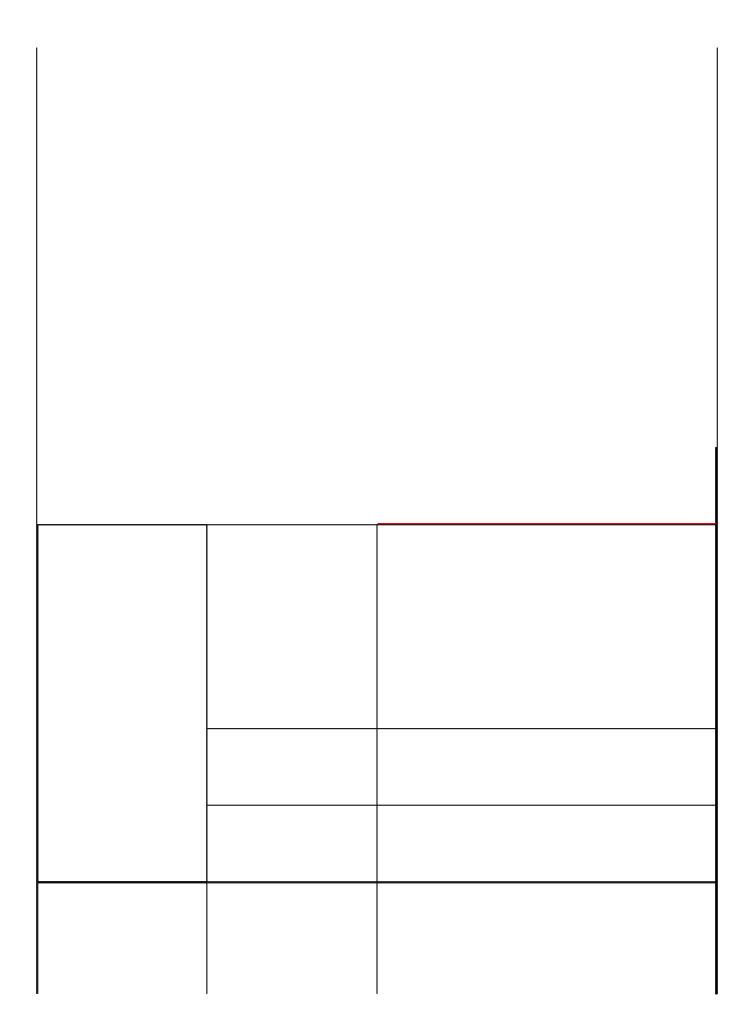
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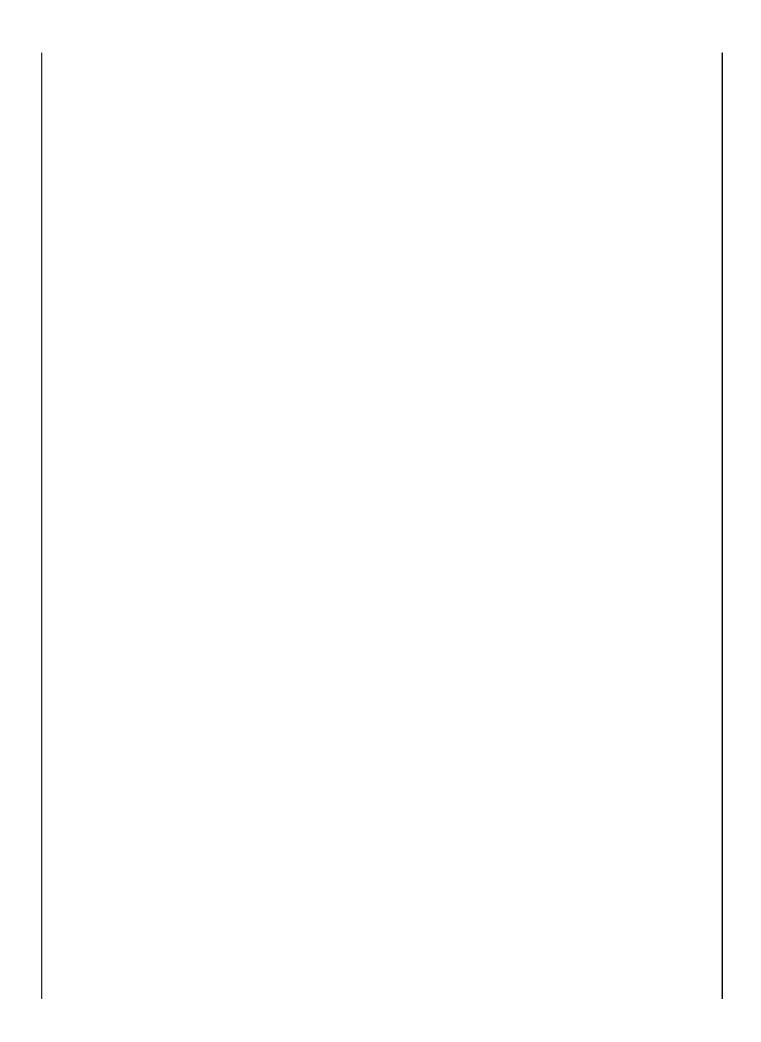
7ci fgY GWXYXi `Y

<u>J]Yk 'WUgg'hja YHUV'Y</u>

H]a YtUV`Y

8 UHY	Hmd Y	7 cbhYbh
K YY_'%'&' '>i `m!'&- '>i `m	@YWnifY	< Ufa cbm@YVMifY. HiYgXUm&('>i `mž'%\$Ua 'UbX %%Ja "
		@YWnffYf." <uff]gcb"7c"]bg< td=""></uff]gcb"7c"]bg<>
		±blfcXi Wfjcb hc h\Y Wti fgY" F Yj]g]cb cZ7 UXYbWfg. ±a dYfZYWh5i h\Ybh]WUbX DYfZYWh5i h\Ybh]W' < U`Z/ 8 YWYdh]j Y / UbX D`U[U" < ck 'Xc'a Y`cXmUbX \Ufa cbmWta V]bY hc Zcfa 'U'WUXYbW3
		D`YUgY'BchY.'Hi hcf]U`g'UbX'Ghi X]cg'VY[]b']b'K YY_ &"
K YY_'&.'' \$'>i `m!') 5i [i gh	@YWn fY	< Ufa cbm@YWhifY. "Hi YgXUm" %'>i `mž'%\$Ua "UbX %%Ua ž']b'; %+"
		@YWnfYf.' <uff]gcb'7c``]bg< td=""></uff]gcb'7c``]bg<>
		A]bcf'_Ymg.'X]ZZYfYbWYg'VYhk YYb'bUhi fU'ž'a Y`cX]W UbX'\Ufa cb]Wa]bcf'gWU'Yg'UbX'h\Y'\Ufa cb]Yg'h\Uh WUb'VY'XYf]j YX'Zfca 'h\Y'bchYg'Uj U]'UV'Y']b'YUW\ gWU'Y"'
		GYWcbXUfmXca]bUbhUbX`gYWcbXUfmXca]bUbh+h\ W\cfXg.`fYj]g]cb`cZh\Y`h\YcfmX]gW ggYX`]b`A G7 %*\$&žk]h\`Ub`Ya d\Ug]g`cb`h\Y]f`i gY`]b`a]bcf`_Ymg"`
	Gh X]c	F\mt\a 'K cf_g\cd.'K YXbYgXUm\$%5i [i ghž'%\$Ua ž %da ž'&da ž'UbX'' da ž']b'; % "
		Hi lcf. GhYj Yb A UW.Ua Yf
	Hi hcf]U`	5i fU`K cf_g\cd.`H\i fgXUm\$&5i [i ghž- Ua ž %\$Ua ž'&da ž'UbX`%da ž']b`; % "
		Hi hcf. 8Uj]X HUmcf
K YY_" .** 5i [i gh!	@YWhifY	< Ufa cbm@YWifY. "Hi YgXUm\$+"5i [i ghž'%\$Ua "UbX %Ua ž']b"; %+"
		@YWnifYf.' <uff]gcb'7c``]bg< td=""></uff]gcb'7c``]bg<>
		• '@YUX]b['HcbY'ff]UXgž'UbX'@YUX]b['HcbY'+h\ W\cfXg'Ug'Y]h\Yf'X]a]b]g\YX'+h\g'cf'\U'Z\X]a]b]g\YX +h\g"
		• 'GYWcbXUfm'@YUX]b['HcbY'lf]UXg'UbX'GYWcbXUfm





F Ygci fWyg

DfYgWf]VYX F Ygci fWfg

51 F 5@=5 GcZk UfY f9ggYbh]U'Ł

H\Y'51 F 5@=5') 'ff7 @C I 8 'J Yfg]cbŁ'YUf! IffU]b]b['gcZk UfY'k Ug'di fWkUgYX'Vm'U```gh XYbhg'k \c'Ybfc``YX`]b A I G7 '%* \$&`A UhYf]U'g/ 'Ghi Wi fYg'cZA i g]W%]b`GYa YghYf'%\&\$% "'Gh XYbhg'8 C 'B C H`\Uj Y'hc'dUm Ubch\Yf'ZYY'k \Yb'Ybfc``]b[']b`A I G7 '%* \$' 'A UhYf]U`g'UbX'Ghi Wi fYg'cZA i g]W&']b`GYa YghYf'&'&\$% 'Ug h\Y'5i fU`]U``]W'bW'``Ughg'Zcf'\&'a cbh\g'Zfca 'h\Y'XUhY'cZdi fWkUgY"

ACC8@9.

A UhYf]U'g'k]``ZfYei YbhmVY'a UXY'Uj U]`UV`Y'hc'U``ghi XYbhg'j]U'h\Y'A ccX`Y'k YVg]hY.``c[!]b'k]h\`mci f ghi XYbh=8 'UbX'dUggk cfXž'UbX'gY`YWh\Y'A I G7''*\$\\$' '7 ci fgY'A cXi `Y''Ghi XYbhg'g\ci `X'a cb]hcf'h\Y A ccX`Y'Y@YUfb]b['a cXi `Y'ZfYei YbhmZcf'i dXUhYg'cb'UggYgga Ybhg'UbX'U`gc'Zcf'WUgg'bchYg'UbX'Zcf qi dd'Ya YbhUfmYl YfWlqYg''

IBGK @=6F5FM

Ghi XYbhgʻg\ci `X`Uj U]``h\Ya gY`j YgʻcZU```h\Y`fYgci fWrgʻ]b`h\Y`I BGK '@]VfUfm`]bZcfa Uh]cb`cb`@]VfUfm gYfj]Wrg`Wb`VY`Zci bX`Uh`\hd.#|bZc"`]VfUfm'i bgk "YXi "Ui #k YV#qYfj]Wrg#gYfj]Wrg*\ha`

FYWca a YbXYX FYgci fWYg

HYI hVcc_Zcf < Ufa cbm

H]hY. H\Y A i g]W]Ub'g; i]XY hc H\YcfmUbX 5bU`mg]q

5 i h\cffgt >UbY D]dYf 7 YbX]bb]b['UbX 9`]nUVYh\ A Ufj]b K Ygh

Di V`]g\Yf. K "K "Bcfhcb/ 7ca dUbm +b\"

9X]h]cb. '&bX'9X]h]cb fl fX'9X]h]cb ']g'U'gc'Uj U]`UV'YŁ'' MYUf'Di V`]g\YX. '&\$%%fl fX'9X]h]cbž'&\$%+Ł

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

Ghi XYbh'ZYXVUW_cb'h\]g'Wei fgY']g'[Uh\YfYX'dYf]cX]WU``mUbX']g'U`k Umg'WUfYZ ``mWebg]XYfYX'k]h\'U'j]Yk hc'UWf]b['cb']h'Webghi Whj Y`mk \YfYj Yf'dcgg]V`Y'': YYXVUW_']g'[Uh\YfYX'Vmj Uf]ci g'a YUbg']bWi X]b['th\Y Zcfa U``A m9I dYf]YbW''Gi fj Ymg''

#b``][\hcZdfYj]ci g`ZYYXVUW_Zfca `ghi XYbhg`]b`h\]g`Wci fgYža cfY`Ya d\Ug]g`\Ug`VYYb`d`UWX`cb`Vf]b[]b[h\Y`WcbW\dhg`Zfca `U```Wca dcbYbhg`cZh\Y`Wci fgY`]bhc`WcgYf`U`][ba YbhfYgdYW]U``mk]h\fY[UfXg`hc`h\Y k YY_`mgW\YXi `Yg`Zcf`YUW\`Wca dcbYbh\z]b`cfXYf`hc`Z fh\Yf`Wcbgc`]XUhY`h\Y`ghi XYbhg'i bXYfghUbX]b[`cZh\cgY`WcbW\dhg"

=a U[Y7fYXY h\Ygh XYbh gibXYfghJbX]b[cZ

7F=7CG

7F=7CG'Dfcj]XYf'7cXY.'\$\$\$-,;