

5 V Y b h Y i Y f_f Y i n Z U \ f h Y b . '+ 'F Y] g Y b 'Z Ø f =\ f Y '6 i W_Y h '@]gh

K]f'k YfZYb'Y]bYb'6`]W_'Ui Z'g]YVYb'5VYbhYi Yf_fYi nZU\fhYbž X]Y'XYb'[fc \Rightarrow Yb'9bhXYW_Yfb'gY`Vgh'k ØfX]['g]bX 5VYbhYi YffY]gYbXY'g]bX']a '5``[Ya Y]bYb'Ub'Y]b'[Yk]ggYg A U \Rightarrow 'Ub'I bVY\U[Yb'[Yk Ò\bh.'7 Ua d]b['Ui Z'Y]bYa 6Yf[[]dZY`Ž'HfY__]b['Xi fW\ XYb'Yfgh]W_YbXYb'8gW\i b[Y`Ž Gdfi b['j cb'Yhk Ug'gY\fž'gY\f'<c\Ya "'8cW\'gY`Vgh'ZØf'XYb\Ufh[YgchhYbghYb'FY]gYbXYb'[]Vh'Yg'Y]b][Y'5VYbhYi Yfž'X]Y Y]bZUW\'i ba Ò[`]W\'U``Y]bY'ni 'VYk À`h][Yb'g]bX'''<]Yf'_ca a Yb?fYi nZU\fhZYf]Yb']bg'Gd]Y`'' A]h'XYf': À\][_Y]hž'DUggU[]YfY']bX]Y'YbhYY[YbghYb'K]b_Y`XYf'K Y`h'ni 'VYZÒfXYfbž'V]YhYb?fYi nZU\fhgW\]ZZY'X]Y'A Ò[`]W_Y]hž'CfhY'ni 'VYgi W\Yb'i bX8]b[Y'ni 'gY\Ybž'X]Y'X]Y'a Y]ghYb'A YbgW\Yb'b]Y'ni 'gY\YbV_ca a Yb'''<]Yf'`]ghYb'k]f'X]Y'Hcd!5VYbhYi Yf_fYi nZU\fhYb $Z\emptysetf'=\{fY'/Ua d\wedge Y`]d/$

K]f'k YfZYb'Y]bYb'6`]W_'Ui Z'g]YVYb'5VYbhYi Yf_fYi nZU\fhYb \check{z} X]Y XYb'[fc $_{y}$ Yb'9bhXYW_Yfb'gY`Vgh'k ØfX]['g]bX

 $5VYbhYi\ YffY]gYbXY'g]bX']a \ '5``[Ya\ Y]bYb'Ub'Y]b'[Yk\]ggYg'A\ U>'Ub' IbVY\U[Yb'[Yk\ O\bh'7Ua\ d]b['Ui\ Z'Y]bYa \ '6Yf[[]dZY`ž'HfY__]b[Xi\ fW\ XYb'Yfgh]W_YbXYb'8gW\ ib[Y`ž'Gdfi\ b['j\ cb'Yhk\ Ug'gY\fž'gY\f<-\Ya\ "8cW\ 'gY`Vgh'ZØf'XYb'\Ufh[YgchhYbghYb'FY]gYbXYb'[]Vh'YgY]b][Y'5VYbhYi\ Yfž'X]Y'Y]bZUW\ 'i\ ba\ O[`]W\ 'U``Y]bY'ni\ 'VYk\ A`h][Ybg]bX"$

<]Yf'_ca a Yb'?fYi nZU\fhZYf]Yb']bg'Gd]Y`"A]h'XYf': À\][_Y]hž
DUggU[]YfY']b'X]Y'Ybh`Y[YbghYb'K]b_Y`XYf'K Y`h'ni 'VYZÒfXYfbž
V]YhYb'?fYi nZU\fhgW\]ZZY'X]Y'A Ò[`]W_Y]hž'C fhY'ni 'VYgi W\Yb'i bX
8]b[Y'ni 'gY\Ybž'X]Y'X]Y'a Y]ghYb'A YbgW\Yb'b]Y'ni 'gY\Yb
VY_ca a Yb"'<]Yf'`]ghYb'k]f'X]Y'Hcd!5VYbhYi Yf_fYi nZU\fhYb'ZØf \Rightarrow fY'6i W_Yh'@gh'Ui Z'fi bX'a]h' 6i W_Yh'@gh 'a Y]bYb'k]f'bUhØf`]W\

<]bk Y]g. '8]Y 'DfY]gY '[Y`hYb 'dfc 'DYfgcbž'VUg]YfYbX 'Ui Z'nk Y] DYfgcbYbž'X]Y 'g]W\ 'Y]bY '? UV]bY 'hY]`Yb"

%"'BcfXdc`

'U`h1 ?UfhY'Y]bYf'5VYbhYiYf_fYi nZU\fh'ni a 'BcfXdc` 2

K Ybb XUg 9]gVfYWXYb ni a 'BcfXdc`' \Rightarrow fY 'JcfghY``i b['jcb'GdU»']ghž XUbb ZØ[Yb'G]Y'X]YgYg'Yl hfYa Y'5VYbhYi Yf' \Rightarrow fYf'Df]cf]hÀhYb`]ghY \]bni "'HU['%'VY[]bbh']b'<Y`g]b_]ž':]bb`UbXž'k c'G]Y'Y]bYb 7\UfhYfZi ['bUWX'A i fa Ubg_']b'Fi gg`UbX'bY\a Yb"

5b'HU['&'VY[]bbh'=\f'5VYbhYi Yf'Ub'6cfX'XYf') \$'MYUfg'cZ'J]Whcfmž Y]bYa 'Uhca [Yhf]YVYbYb'9]gVfYWXYfž'[YZc`[h'j cb'j]Yf'HU[Ybž']b XYbYb'G]Y'Xi fWX'XUg'Uf_h]gWXY'9]gdU_Yh'VfYWXYb"'DUggU[]YfY _ÒbbYb'Y]bYb'cdh]cbU`Yb'<Y`]_cdhYfZi ['ZØf'Y]bY UhYa VYfUi VYbXY'@ ZhUi ZbU\a Y'XYg'k Y]h'Ài Z][Yb'5f_h]gWXYb CnYUbg'i bhYfbY\a Yb"

5b'HU['+'YffY]W\Yb'G]Y'XYb'BcfXdc`ž'k c'U``Y'<]a a Y`gf]W\hi b[YbbUW\'GØXYb'nY][Yb"'8cfh'_ObbYb'G]Y'Y]bYb'Dc`Ufgdfi b[']b'X]YY]g][Yb'; Yk AggYf'k U[Yb'cXYf'g]W\'ghUhhXYggYb'ZØf'Y]bYjYfbØbZh][YfY::U\fh'a]h'XYa'<Y]»`i ZhVU``cb'YbhgW\Y]XYb"

%('HU[Yž'&* "- -) `` ž'E i Uf_'9I dYX]h]cbg

&"'5`Ug_U

 $"U"h1 ? UfhY"Y]bYf"5VYbhYi Yf_fYi nZU\fh"bUWX "5"Ug_U 2$

K Ybb'G]Y'bcW\'b]W\h'[Ubn'VYfY]h'Z\'0f'Y]bY'A]gg]cb'ni a 'BcfXdc\'g]bX\'z'hYghYb'G]Y'X]Y'; Yk \\aagagYf'ghUhhXYggYb'a]h'Y]bYf'X]YgYf 5\'Ug_U!5VYbhYi Yf_fYi nZU\fhYb"

 $= fY \cdot FY \cdot gY \cdot VY \cdot [bbh']b \cdot XY \cdot f \cdot U \cdot Ug_]gWXYb \cdot < UidhghUXh' \Rightarrow bYUi \check{z} \cdot k \cdot c \cdot G]Y$

⇒fY'7fYk 'hfYZZYb'i bX'Yg'g]W\'[Ya Øh`]W\'a UW\Ybž'k À\fYbX'G]Y ni a 'Hcb[Ugg'BUh]cbU`': cfYgh'gY[Y`bž'XYa '[fÒ» hYb'BUh]cbU`k U`X XYf'I G5"

Jcb`Xcfh`Uig`\UVYb`G]Y`Y]b`dUUf`UWh]cbfY]W\Y`K cW\Yb`a]h HfY__]b[ž'; `YhgW\Yfk UbXYfi b[Ybž'?U^U_ZU\fYbž'DUXX`YVcUfX]b[ibX`GW\bcfW\Y`b`gck]Y'; Y`Y[Yb\Y]hYbž'6i W_Y`k U`Yž GW\kYfhk U`Yž'6ÀfYbž'9`W\Y`ibX`BYfnY`ni `gY\Yb"

%) 'HU[Yž'UV'*", () '' \check{z} 'l b!7fi]gY'5Xj Ybhi fYg

' "5bhUf_h]g

 $"U"h1 ? UfhY"Y]bYf"5VYbhYi Yf_fYi nZU\fh"]b"X]Y"5bhUf_h]g 2$

 $9g`[]Vh`nU\ \hat{f}Y]WXY`5VYbhYiYf_fYinZU\ fhYbž`X]Y`Y]bYb`Gdfib[`nif5bhUf_h]gWXYb`<U`V]bgY``UbV]YhYb"`9bhgWXY]XYb`G]Y`g]WXghUhhXYggYb`ZØf`YhkUg`;fÒ»YfYgž`]bXYa``G]Y`]b`X]Y`:i»ghUdZYb`XYf[fc»Yb`9bhXYW_Yf`GWchhibX`5aibXgYb`hfYhYb"$

 $8]Y \cdot 5_UXYa]_ \cdot G \setminus c_U \cdot g_]m \cdot Z \land fh \cdot h]YZ \cdot]b \cdot X]Y \cdot Ub \cdot hUf_h]gW \land Y \cdot K] \cdot Xb]g$ $i b X \cdot g Y [Y \cdot h \cdot Ua \cdot F \cdot c \cdot g g] \cdot GW \land Y \cdot Z Y]g \cdot j \cdot c \cdot f \lor Y] \check{z} \cdot X Ya \cdot [f \grave{O} \Rightarrow h Y b$ $gW \land k \]a \quad a \quad Yb \times Yb \cdot 9]g \cdot XYf \cdot K \quad Y \cdot h \check{z} \cdot i \quad b \times \cdot Vf]b [h \cdot G]Y \cdot \check{z} \cdot k \quad Ybb \cdot X Ug \cdot K \quad Yhh Yf \cdot Yg$ $ni \quad \cdot \grave{A} \cdot g h \check{z} \cdot ni \quad f \cdot F \cdot c \cdot g g] \cdot \not b \cdot g Y \cdot \check{z} \cdot k \quad c \cdot G]Y \cdot XYb \cdot A \quad ci \quad b \cdot h \cdot 9 f Y \lor i \quad g \cdot f K Yb \cdot U_h]j \quad g h Y b$ $J \quad i \quad \cdot _Ub \cdot XYf \cdot 5b \cdot h Uf_h]g \not k \cdot VYg i \quad W \cdot Yb \cdot _\grave{O}b \cdot b Yb \cdot "i \quad b X \cdot X]Y \cdot \backslash]g h c f]g W \land Yb$ $G h \grave{A} \cdot h h Yb \cdot G \backslash UW_ \cdot Yhcb \quad g \cdot \langle i \quad h \check{z} \cdot G W c \cdot h h \quad g \cdot \langle i \quad h f g \not k \cdot i \quad b X \cdot X]Y \cdot G h Uh]c \cdot b Yb \cdot G W c \cdot h h$ $i \quad b X \cdot A \quad W \quad i \quad f X c \cdot "$

') 'HU[Yž'UV'&&"' \$\$``ž'<Yf]hU[Y'9|dYX]h]cbg

("; fÒb`UbX

'U`h1 ?UfhY'Y]bYf'5VYbhYiYf_fYinZU\fh'bUW\; fÒb`UbX 2

A]h'Y]b][Yb'XYf'k Y`hVYghYb'8 UfghY``i b[Yb'XYg'BcfX`]W\hg'gc``hY X]Y'fY]bY'K]`Xb]g'; fÒb`UbXg'Ui Z'XYf'K i bgW\`]ghY'Y]bYg'YXYb 5VYbhYi fYfg'ghY\Yb" 8]YgY'?fYi nZU\fh'j cb'Ei Uf_'9I dYX]h]cbg'gY[Y`h'Xi fW\'a]h 9]gVYf[Yb'ØVYfgÀhY': 'cfXY'i bX'V]YhYh'DUggU[]YfYb'X]Y A Ò[`]W_Y]hž'Ui Z'6Yf[Y'ni '_`YhhYfb'i bX'<YfXYb'[fUgYbXYf A cgW\i gcW\gYb'Ua'<cf]ncbh'ni 'VYcVUW\hYb"

G]Y'VY[Y[bYb'Uf_h]gW\Yf'H]YfkY`h']a ; fÒb`UbX!BUh]cbU`dUf_'i bX VYgi W\Yb'≠hceecfhccfa]]hž'Y]bY'XYf'UV[Y`Y[YbghYb'; Ya Y]bXYb XYf'K Y`hž']b'XYf'X]Y'6Ykc\bYf'k]Y']\fY'JcfZU\fYb'jcf'<i bXYfhYb jcb'≯J\fYb'jca'@UbX'`YVYb"

%('HU[Yž'UV'+"--) ' ž'E i Uf_'9| dYX]h]cbq

) "BcfXk YghdUggU[Y

'U'h1 ? UfhY 'Y]bYf'5VYbhYi Yf fYi nZU\fh'bUWX ; fÒb`UbX 2

 $\label{thm:local-control} $$ \lambda f^i b X Y f h Y `Ub[`ghUfV Yb `A Y b g W Y b `V Y] `X Ya `J Y f g i W ž `X] Y g Y $$ D U g g U [Y `ni `Xi f W e i Y f Y b ž] b `X Y f `< c \ ZZ b i b [ž `Y] b Y `G W] \ Z Z Z U \ f h g f c i h Y n k] g W Y b `X Y a `5 h `Ub h] _ `i b X `X Y a `D U n] Z] _ `ni `Y f f] W h Y b "$

5i Z'⇒fYf'FY]gY'Xi fW\'XYb'?UbUX]gW\Yb'5f_h]gW\Yb'5fW\]dY`ž <Y]a Uh'XYg'9]gVÀfYbž'XYg'; f]nn`mVÀfYbž'XYg'A cgW\i gcW\gYbž'XYg ?Uf]Vi g'i bX'XYg'K U`fcggYgž'ghY\h'Ui W\'XUg'6YcVUW\hYb'j cb K]`Xh]YfYb'Ui Z'XYa 'Dfc[fUa a "

%' 'HU[Yž'UV''%%"- -) '` ž'C bYC WYUb '9I dYX]h]c bg

* "'D]hWU]fb

8]Y 'A J '7 `Uma cfY' = a UW\h'UW\h'A U``]a '\\J\f'Y]bY'Fi bXfY]gY'j cb : $fUbnOg]gW.!Dc`mbYg]Yb'bUW\'D]hWU]fb'' 8 Yf'U_hi Y``Y'NY]hd`Ub'g]Y\h Y]bYb'5i ZYbh\U`h'j cb'' 'cXYf'%$'BÀW\hYb'j cfž'VY]'XYa '6Ygi W\Yf]\fY'Y][YbY'I bhYf_i bZh'gi W\Yb'a ØggYb''$

9g'[]Vh'a Y\fYfY'dUn]Z]gW\Y'?fYi nZU\fhgW\]ZZYž'X]Y'D]hWU]fb'Ui Z
]\fYf'FY]gYfci hY'Ybh\U`hYbž'UVYf'X]Y'@UbXi b['\Àb[h'j cb'XYb
GYYVYX]b[i b[Yb'UV'i bX'g]Y'V'Y]VYb'bi f'ZØf'Ghi bXYb"'8]Y'A G
7U`YXcb]Ub'G_m'j cb'NY[fU\a'9|dYX]h]cbg'\Uh'g]Y']b'XYf
JYf[Ub[Yb\Y]h'XfY]a U`'Ui Z']\fYf'?fYi nZU\fh'j cb'HU\]h]'ni f
CghYf]bgY`'VYgi W\h'i bX'j Yfgdf]W\h'a]h'Y]bYf'?UdUn]h\h'j cb'%%(
Y]b']bh]a YfYg'9f`YVb]g'U`g']\fY'[fÒ»YfYb'DYbXUbhg"

A J '7 `Uma cfY' = '& 'HU[Y 'GY[Y`b'] cb': fUbnÒg]gW !Dc`mbYg]Yb'dfc GhfYW_Yž') "\$\$\$ 'B N8 'fl "&, +'I G8 Ł'bi f'ZØf'XYb'HfUbgdcfhž'6i W\i b[\emptyset VYf'XUg': fYa XYbj Yf_Y\fgUa h

A Gʻ7 UʻYXcb]UbʻG_m '&%'HU[YžʻUV'%, "(, \$'' i bX'VY]b\U`hYh'HU\]h]ž A Ufei YgUgž'Hi Ua chi gʻi bX'X]YʻCghYf]bgY`ž'NY[fU\a '9I dYX]h]cbg

+ "K YghUZf]_U

 $"U"h1 ? UfhY"XYf"K YghUZf]_U!?fYi nZU\fh 2$

$$\begin{split} &5Zf]_U``Y]XYh`gY]h``Ub[Ya `ibhYf`Y]bYa `=a U[YdfcV`Ya "`Jcb`?f]Y[ibX`<ib[Yf`V]g`\]b`ni `?]bXYfgc`XUhYb`ibX`a cXYfbYb`D]fUhYb``X]YgYf`?cbh]bYbh`kifXY`jcb`Y]bYf`; YgW\]W\hY`jc``Yf`GW\fYW_Yb\Y]a [Ygi W\hž`UVYf`Yf`Yf\c`h`g]W\ž`XU`g]W\`]a a Yf`a Y\f`gY]bYf``@AbXYf`ZØf`Hcif]ghYb``OZZbYb"$$

K]`XgW\i hn[YV]YhYž'`YV\UZhY' < UZYbgh\XhY'i bX'W\Ufa UbhY'8\OfZYf V]YhYb'5i g`\abxYfb'j]Y\\z'k]Y'G]Y'Ui Z'X]YgYf'?fYi nZU\fh'j cb

5Xj Ybhi fY '5ggc W]UhYg 'gY\Yb 'k YfXYb" '6Y[]bbYbX ']b '? UdghUXh\UVYb 'G]Y 'X]Y 'A Ò[`]W_Y]hž 'XYb 'HUZY \VYf['i bX 'a Y\fYfY 'UbXYfYGY\Ybgk ØfX][_Y]hYb 'Ub '@UbX 'ni 'VYgi W\Ybž 'VYj cf 'G]Y 'Ub '6cfX 'XYf A G '9| dYX]h]cb 'ZØf 'Y]bYb 'HU['Ui Z GYY '[Y\Yb"

 $\label{lem:condition} $$Jcb`Xcfh`Uig`VYgiWXYb`G]Y`Y]bY`FY]\Y`ZUgn]b]YfYbXYf`CfhYžXUfibhYf`5b[c`Už`?cb[c`ibX`G]YffU`@YcbYž`X]Y`@jj]b[ghcbY`gY`Vghk ØfX][`g]bX"$

@Y]hV]`X. 8fYUa gh]a Y

·

8 YhU]`q

6Ygi WXYb G]Y i bg Ui Z Y]bY!fY]gY "XY