

?fmdhc!; YgWXÀZhga Ubb'j YfgWXk]bXYhž'U`g YfghY'[f]YWX]gWXY'?fmdhckÀ\fi b[ni gUa a YbVf]WXh'

8 Yf A Ubbž XYf XUgʻI bhYfbY\a Ybʻ\]bhYf XYfʻUʻg; f]YW\Yb`UbXgʻYfghYfʻ?fmd hck À\fi b[ʻVY_UbbhYb?fmd hck À\fi b[ʻVY_UbbhYb?fmd hck À\fi b[ʻY]hYhYž\Uh'Ub[YV`]W\X]Yʻj Yfi fgUW\h Wc]b/ Ua d/, &%+/gʻDfY]gʻni ʻg]b_YbžʻUʻgʻYfʻX]YgYbʻA cbUh j YfgW\k UbX" 8 Yf A UbU[Yf k Uf Yhk Uʻnk Y]ʻK cW\Ybʻ`Ub[b]W\h'Ui ZʻXYa ʻF UXUfžʻVYj cf YfʻXYfʻDfYggYʻgW\`]Y»`]W\a]hhY]ʻhYžʻXUggʻYfʻVUʻXʻni fØW__Y\fYbʻk]fXžʻi bXʻX]Y 5 bgW\i `X][i b[Ybʻni fØW_k]YgžYf`\UVYʻXYbʻA Uf_hʻXYf?fmd hck À\fi b['ni a ʻ5 Vghi fn`[YVfUW\h'`\Y``Yb]gW\`7c]b 9]bVfi W\`]ba]hhYbʻXYfʻGcf[YbʻXYfʻ?fmd hc! \DiyYghcfYbʻØVYf XYbʻJYfV`Y]Vʻj cbʻ7c]b/ Ua d/, &%+/gʻGW\ÒdZYfʻJUb[Y`]g HgUdUgžʻYa UbXʻa]hij YfgW\]YXYbYbʻ; YgW\ÀZhg]bhYfYggYb i bXʻGdcbgcfʻY]bYfʻ6Ug_YhVUʻ`a UbbgW\UZh`]bʻ; f]YW\Yb`UbXžj YfÀf[YfhYʻX]Yʻ\DiyTghcfYbʻY]bYfʻ?fmd hck À\fi b[žX]YʻYf [YgW\UZYb`\UhhYž'UʻgʻYfʻ5bZUb['/Ua d\Y``]d/

8 Yf A Ubbž XYf XUg I bhYfbY\a Yb`\]bhYf XYf U`g; f]YWXYb`UbXg YfghYf? fmd hck À\fi b['VY_UbbhYb? fmd hck À\fi b['Y]hYhYž\Uh Ub[YV`]WX 'X]Y j Yfi fgUWXh Wc]b g DfY]g ni 'g]b_Ybž U`g Yf X]YgYb A cbUh j YfgWXk UbX"8 Yf A UbU[Yf k Uf Yhk U nk Y] K c WXYb ``Ub['b]WXh Ui Z XYa F UXUfž VYj cf Yf XYf DfYggY 'gWX`]Y»`]WX 'a]hhY]`hYž XUgg Yf VU`X ni fØW_Y\fYb k]fXž i bX 'X]Y '5 bgWXi `X][i b[Yb ni fØW_k]Ygž Yf \UVY XYb A Uf_h XYf? fmd hck À\fi b['ni a 5 Vghi fn [YVfUWXh"'

\Y``Yb]gW\'7c]b'9]bVfi W\']ba]hhYb'XYf Gcf[Yb'XYf'?fmdhc!=bjYghcfYb'ØVYf'XYb JYfV`Y]V'jcb'7c]bg'GW\ÒdZYf

J Ub[Y`]g`HgUdUgž'Ya UbX`a]hij YfgWX]YXYbYb; YgWXÀZhg]bhYfYggYbibX`GdcbgcfY]bYf`6Ug_YhVU``a UbbgWXUZh`]b; f]YWXYb`UbXžjYfÀf[YfhY`X]Y`\DjYghcfYb`Y]bYf`?fmdhckÀ\fib[ž'X]Y`Yf
[YgWXUZZYb`\UhhYž'U`g`Yf`5bZUb[BcjYa VYf`d`Ohn`]WX'jYfgWXkUbX"8Yf`DfY]g'jcb`<Y``Yb]W7c]b`fkB7Ł'ghØfnhY`UVž'U`g`Yf`b]WXhaY\fjYfZØ[VUf`kUf`Jjcb`ØVYf`%ž&\$`IG8`Ua`, "BcjYa VYf`UiZibhYf\$ž(`IG8`nia`NY]hdib_h`XYg`GWXfY]VYbg"`8Ug`]gh'bUWX`XYa9ffY]WXYb`XYg`5``nY]h\cWXgjcb`(ž(`IG8`Ua`%("`\sib)]`&\$&%"

EiY``Y. 7c]ba Uf_YhWUd`

Hci f]ga i gVfUbW\Y`ni `Yf`Y]W\hYfbži bX`k]fX`gY]hXYa `j cb A YbgW\Yb`Ui g`XYf`[UbnYb`K Y`h`[Y_Ui Zh"

JUb[Y`]g'HgUdUgž'; fØbXYf'j cb'<Y``Yb]W7c]b"'EiY``Y. BYk a cbYm"[f'

K À\fYbX'VY]'<B7'6YXYb_Yb'[YÀi »Yfh'k YfXYb'7c]b' ⊕\UVYfž'gY]b

J YfgWk | bXYb'U`Ufa]YfhY'Gd]Y`Yf'i bX'UbXYfY'A]hUfVY]hYf'j cb

€b]_cg'B]_U]Ug'67ž'XU'Yf'XYb'JYfY]b'Z]bUbn]Y``i bhYfghØhnh"

HgUdUgž'XYf'Ui Wk']b'XYf'; Ughfcbca]Y'i bX'GWk]ZZZU\fh'hÀh][']ghž'\Uh
6Yf]WkhYb'ni Zc`[Y'Ui Wk'XYb'DfYa]Yfa]b]ghYf'j cb'?UhUf'j YfÀf[Yfhž
U`g'gY]bY':]fa Už'X]Y'a]h'XYf'JYfk U`hi b['j cb'GWkY]Wk'?\U`]X'V]b
?\U`]ZU'V]b'5VXi`Un]n'5``H\Ub]g'Gi dYfmUWkh'5``A]feUV'VYUi ZhfU[h
kifXYž'XYf'6YgUhni b[']\fY'@Ò\bY'b]Wkh'nU\`hY'"

. . .

Hfchn XYf < B 7 7 c]b B UW XYa < Yff HgUd Ug Ui Z[Y\Ofn \ UhhYž Ubg HY `Y Zcb `ni `[Y\Ybž VY[Ubb `Yf `c ZZY bg]W h`]W `Ub `K Yfh `ni `j Yf`]YfYb " 9f`\Uh _Øfn`]W `6Y\Ui dhi b[Yb `ni fØW_[Yk]YgYbž `Yf`\UVY `XYb FØW_[Ub[Xi fW XYb J Yf_Ui ZgY]bYf `A ØbnYb `j Yfi fgUW h" +b Y]bYa `; YgdfÀW `a]h XYf `NY]hi b[`H\Ya U VYghUbX `XYf `D\Ub hca!; YgW ÀZhga Ubb `X]YgY `K c W Y `XUfUi Zž `XUgg `Yf `X]Y `[f]Y W]gW Y ?fmd hc `hUhgÀW `]W `_cghYb`cg `j YfgW Yb_h`\UVYž `a UW hY `gY]bY Yb[Yb `A]hUfVY]hYf `ZØf `XYb `@Afa `j YfUbhk cfh`]W `i bX `_ØbX][hY Ubž `XUgg `Yf `VU`X `ni `gY]bYb `[YgW AZh`]W Yb `J YfdZ]W hi b[Yb ni fØW__Y\fYb `k YfXY" `9f `VY\Ui dhYhYž `A YX]YbVYf]W hY `gY]Yb `ZØf XYb `DfY]gj YfZU`` j YfUbhk cfh`]W ž `VYghUbX `XUfUi Zž XUgg `gY]bY 5Vk YgYb\Y]h _Y]bY `F c ``Y `gd]Y Yi bX `Yf_`AfhY.

9g·ZÀ``hž·f]W\h][ž·Ub·XYa `]W\`bUhØf`]W\b]W\h'VYhY]`][h·V]b"
K Y]``]W\`bcW\`b]Y`Y]bY`Y]bn][Y`?fmdhck À\fi b['j Yf_Ui Zh\UVY"\=\W\\UVY_Y]bYž\XU\]W\``YhnhYb': fY]hU['U``Yg\cghYb`cg'ØVYfk]YgYb\\UVYž'k]Y`]W\`Yg'\UVYž'c\bY'Y]bYbY]bYb

 $\label{thm:local-controller} HgUdUg`ZØ[hY`\]bni ž`Yf`ZØ\fY`; YgdfÀW\Y`a]h`Y]bYa `bYi YbA UbU[YaYbhhYUažia`X]Y`@YVYbgZÅ\][_Y]h`XYf`?fmdhcg]W\Yfni ghY``Yb"`\dank]gW\Yb`<B7`7c]b g`XYfnY]h][Y`: Ø\fi b[`\Uh]\b`XYaYbh]Yfh`i bX`X]Y`^2 ZZYbh`]W_Y]h`XUfØVYf`]bZcfa]Yfhž`XUgg`YfXUg`Dfc^Y_h`b]W\haY\f``Y]hYh"`\dank Y\f``Y]hYh"`\dank Y\f``Y]bYf`j YfÒZZYbh`]W\hYb`9f_`Àfi b[ki fXY`VYhcbhž`XUgg`HgUdUg`bUW\XYb`^Øb[ghYb`9fY][b]ggYb`b]W\haY\f`XYf`79C`]gh`i bX`b]W\h`Ub`9bhgW\Y]Xi b[Yb``ØVYf`XYb`6Yhf]YVibX`X]Y`9bhk]\W_`i b[`XYf`?fmdhck À\fi b[`VYhY]`][h`]gh'$

±0 'XYa '±0 hYfj]Yk 'a]h'H\Ya Už'XUg' X]Y'K U\f\Y]h

k]YXYf\YfghY``Yb 'gc``hYž'ZØ\fhY'J Ub[Y`]g'HgUdUg' YfbghY

[Ygi bX\Y]h`]W\Y'; fØbXY 'ZØf'gY]bYb'j cfØVYf[Y\YbXYb'FØW_ni [Ui g'5h\Yb'i bX'X]Y'ÒZZYbh`]W\Y'G]W\h'Ubž'gU[hY'UVYf'Ui W\ž'XUgg'YfXYb'GW\f]hh'Ui Z'5bfUhYb'gY]bYg'5bk U`hg'[YhUb'\UVY''' , Vf][Ybgž]W\'k i fXY'Ui g'_Y]bYa '; fi bX'j cb'Y]bYa 'GhUUhgUbk U`h'[Yfi ZYb žVYhcbhY'HgUdUg''8]Y'JYfÒZZYbh`]W\i b['ghY``h'ZYghž'XUgg'X]Y

[f]YW\]gW\Yb'GhfUZj YfZc`[i b[gVY\ÒfXYb'X]Y'9bhk]W_`i b[Yb']b

XYa ': U``X]g_fYh'ØVYfk UW\h'\UVYb''

 $K \ Ug'XYb_gh'Xi''k \]fX'XUg'GWX \]W_gU`'jcb'; f]YWXYb`UbXg$ $YfghYf'?fmdhck A`\fib['ibX']`\fYa''GWX OdZYf'gY]b3''GU[YbG]Y'Yg'ibg']a''?caa YbhUfVYfY]WX'ibhYb''$

6] `XbUW k Y]gY. `G\ i hhYfghcW_Z'D] UVUmZ'K]_] '7ca a cbg

 $\label{eq:continuity} \textbf{K} \ \ \textbf{Y} \] \textbf{h} \textbf{Y} \ \textbf{f} \ \textbf{Y} \ \textbf{Y} \ \textbf{Y} \ \textbf{Y} \ \textbf{h} \textbf{Y} \ \textbf{b} \ \textbf{UW} \ \textbf{f} \] \textbf{W} \ \textbf{h} \textbf{Y} \ \textbf{b}$

: U``g'8i 'Yg'j YfdUggh'\Ugh

.

fZi bWh]cbfXž'gž']XŁ'o'j Uf''qž'Z'g'1 'X"[Yh9`Ya Ybhg6mHU[BUa YfgŁQ\$Q']Z'fX"[Yh9`Ya Ybh6m=Xf]]XŁŁ'fYhi fb/'q'1 'X"WfYUhY9`Ya YbhfgŁ/'q']X'1]X/'q'gfW1 "\hhdg.##WcbbYWh"ZUWYVcc_"bYh#YbSl G#gX_"'q, I ZVa `1 %/j Yfg]cb1j' "&"/'Z'q'dUfYbhBcXY"]bgYfh6YZcfYfl'qž'Z'gŁ/'qfKcW'a YbhžfgWf]dhfz'fZUWYVcc_!qgX_fkŁ/

6 Ygi WX Yb 'G]Y 'i bg 'Ui Z. '_fmd hc!bYk g"Uh