

MUSC4103

 $5\,Xj\;Ub\,W\!\!/X\,{}^{\cdot}G\,h\,\,X]\!Y\,g^{\cdot}]b\,{}^{\cdot}A\;i\;g]W\!\!<\,]ghc\,fm\,{}^{\cdot}Ub\,X\,{}^{\cdot}7\,i\;\,{}^{\cdot}h\;\,fY\,{}^{\cdot}\%$

HYfa 'C bY''# '&\$&\$

7ci fgY'Cj Yfj]Yk

Ghuzz 7 cbhuWh8 Yhu]`g

'7cbj Ybcfg'

B Ua Y	9a U]`	5j U]`UV]`]m	@cWJhjcb	D\cbY
; Ycf[]U'@]_Ybg		H\ifgXUmg '"\$\$!("\$\$da 'cf'Vm Uddc]bha Ybh		

GWkcc~7cbhJWh~abZcfa Uh]cb

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

D\cbY.'f\$&E'-',)'(,)*

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

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

 $\label{thm:constraint} $$HY'GWKcc``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'hc'FYgdYWZI``m5W_bck`YX[Y'h\Y'HfUX]h]cbU``7ighcX]Ubgžh\Y'6YXY[U``fPYbg]b[hcb'WJadigłž; UX][U``fP]hmUbX'5fhV'8Yg][b'7UadigYgŁ'UbX'h\Y'B[ibbUkU`dYcd'Y'fbighfU`]Ub'8YZYbWY': cfWY'5WUXYam]b'7UbVYffUŁ'cZh\Y'`UbXg'k\YfY'YUWX'WJadig'cZIBGK']g`cWJhYX''$

7ci fgY 8YHJ] g

7 fYX]hDc]bhg**

Gi a a UfmcZh\Y 7ci fgY

Gi VYWh5fYU. ? ge[U

H\]g`Wci fgY`YI Ua]bYg`K YghYfb`7`Ugg]WU``a i g]WdYfZcfa UbWY`]b`]hg`W\`h fU``UbX`\]ghcf]WU``WcbhYI hg" Gh Xm]b['h\Y`UYgh\Yh]Wci hcc_ž'fc`Y`UbX`Z bWhcb`cZWca dcgYfgž'dYfZcfa Yfg`UbX`Ui X]YbWYg`Zfca 'h\Y 6Ufcei Y`dYf]cX`i d`hc`h\Y`&\$h\`7 Ybh fmdfcj]XYg`U`Zcfi a 'Zcf`mci 'hc`YI d`cfY`\ck 'dYfZcfa UbWY`ghmYg W\Ub[Y`]b`hUbXYa 'k]h\`g\]Zh]b['gcW]U``bcfa gž'Wca dcg]h]cbU``dfYfc[Uhjj Ygž'UbX`hYW\bc`c[]WU` XYj Y`cda Ybhg`]b`]bghfi a YbhWcbghfi Wh]cb`UbX`a cfY`[YbYfU``m"

6Y]b['U'@Yj Y`'('WcfY'Wci fgYz']hXYYdYbg'_bck `YX[Y'[U]bYX'UbX'fYZ]bYg'g_]``g'XYj Y`cdYX'Uh'@Yj Y`g'%l' a i g]Wc`c[m'UbX'dYfZcfa UbWY'`UV'Wci fgYg"' =b'dUff]W\`'Ufz']hVi]`Xg'cb'A i g]W'5 'DUbcfUa U'VmfYj]g]h]b[gca Y'cZh\Y'WcbW'dhgz'fYdYfhc]fYz'UbX'\]ghcf]WU''dYf]cXg'ghi X]YX"' =h'U`gc'Wca d`Ya Ybhg'DYfZcfa UbWY''@UV Wci fgYg'VmZcW'g]b['cb'\]ghcf]WU''dYfZcfa]b['dfUWf]WYg'UbX'ghmYg'cZ]bhYfdfYhUh]cb"

7 ci fgY @YUfb]b[Ci hWca Yg

- %" G\ck 'Ub'Yb\Ub\W'X'UV]`]mihc'UbU`mnY'UbX'Yj U`i Uh\Y'W`hi fU`'Wcbghfi \Wg'Ug'Udd`]\\\Y'Y'hc'h\Y dfU\\\W'\\Y'cZa i g\\\
- &" 8 Ya cbghfUhY k Y```XYj Y`cdYX`Wca a i b]\WUh]cbg`g_]``g`h\UhfY`mcb`UXj Ub\WX`X]g\\]d`]bUfm_bck `YX[Y UbX`ZJa]`]Uf]\mik]h\`\Wf]h]\WU``h\Ycfm'UbX`]\mig`i gYg`]b`cfXYf`\mathbb{'\Wc\YfYbh'UbX`\Wcbj]\b\\]b[Uf[i a Ybhq
- ' " 7 cbj YmiU`VfcUXYf`_bck `YX[Y`cZfYdYfhc]fY`UbX`XYYdYf`i bXYfghUbX]b[`cZ]hg`fY`Uh]cbg\]d`hc`gcW]U`ž\]ghcf]WU``UbX`W``hi fU``hfYbXg"

HYUWX]b['GhfUhY[]Yg'

H\Y`Wci fgY`]g`HUi [\hih\fci [\``YWh fYg`UbX`h hcf]U`gžk]h\`fY`Yj UbhUggYgga Ybh'`H\Y``YWh fYg`f&`\ci fg YUW\`k YY_Łžk]```dfcj]XY`]bZcfa Uh]cbžX]gWi gg`gY`YWhYX`fYUX]b[gžgh]a i `UhY`ei Ygh]cbgžUbX`[]j Y`a i g]WU`YI Ua d`Yg`h\fci [\`h\Y`i gY`cZUi X]c!j]gi U``fYgci fW\g"`K\]`Y`X]gWi gg]b[`U`k]XY`fUb[Y`cZfYdYfhc]fY`]b`]hg W`hi fU`!\]ghcf]WU``WcbhYI hž'h\Y``YWh fYg`k]``]bhfcXi WY`ghi XYbhg`hc`_YmUi h\cfg`cb`dYfZcfa UbW\ž\]bghfi a YbhU``hYW\b]ei Ygž'UbX`a i g]WU``UYgh\Yh\Wg`Ug`kY```Ug`fY`Yj UbhX]gW]d`]bUfmXYVUhYg"`H\Y`h hcf]U`g k]```YbUV`Y`ghi XYbhg`hc`XYYdYb`h\Y]f`i bXYfghUbX]b[`cZh\YgY`]ggi Yg`h\fci [\`XYVUhYg`UbX`X]gWigg]cbg f]bWi X]b[`[fci d`k cf_ŁžYI Ua]bUh]cb`cZUi X]c!j]gi U``YI Ua d`Yg`UbX`Wf]h\WJ`Yb[U[Ya Ybhk]h\`gYhfYUX]b[g"

±0X]j]Xi U``UbX`gY`ZX]fYWhYX``YUfb]b[`]g`XYj Y`cdYX`VmYbWci fU[]b[`ghi XYbhg`hc`gY`YWhh\Y]f`ck b`Yl Ua d`Yg Zcf`ghi Xm]b`h\Y`g\cfnk f]h]b[`hUg_`UbX`U`gc`VmfYei]f]b[`h\Ya `hc`XYj]gY`h\Y]f`ck b`a U'cf`dfc'YWh]b Wcbgi `hUh]cb`k]h\`h\Y``YWhi fYf"

5ggYgga Ybh

F YZYfYbWYg'a i ghVY'Zcfa UthYX'Ug'dYf'th\Y'Hi fUV]Ub#5 Z [USYa ? S`gS^aXE fk WZccfbcfjb['gmghYa "'5`` Ugg][ba Ybhg'a i ghVY'gi Va]thYX'Ug'Ub'Ya U]`'UthUWXa YbhfiA]WfcgcZnK cfX'XcW a Ybhg'cb`mŁ'hc ["'i]_Ybg4 i bgk "YXi "Ui 'D`YUgY'fYZYf'hc'th\Y']bghfi Wfjcbg'Ug'hc'th\Y'Z|bYf'XYhU]`g'fY[UfX]b['gi Va]th]b[Ugg][ba Ybhg'WcffYWhm''H\YgY']bghfi Wfjcbg'WUb'VY'Zci bX'cb'th\Y'Wci fgY'g'A ccX'Y'dU[Yž'Ug'WUb'U'XYhU]`YX YI d`UbUhjcb'cZUggYgga Ybh'UbX'a Uf_]b['[i]XY`]bYg"

5ggYgga Ybh'HUg_g'

5ggYgga Ybh'hJg_	K Y][\h	8iY'8UhY	Gh XYbh@YUfb]b[Ci hWca Yg 5ggYggYX
G\cfhidUdYf	' \$1	% #\$' #&\$&\$`%\$.\$\$`5A	% Z
; fci d'k cf_'dfYgYblUlf]cb'	' \$I	DfYgYbrUr]cbg'k]``'rU_Y'd`UW Xi f]b['rh\Y'ri rcf]U`g']b'k YY_g , ž- '/'%\$"'f5df]`'-h\ž%*h\ž &' fXŁ	%ž&
A U⁄cf′dfc YWh	(\$1	\$, #\$) #&\$&\$`%&.\$\$`DA	%ž&Ž

5ggYgga Ybh'8YHJ]`g

5ggYgga Ybh% G\cfhdUdYf

 $\textbf{GhUfhXUhY}. \ \textbf{Bch5dd`]} \textbf{WUV`Y}$

@Yb[h\.'%\$\$\$'k cfXg

8D/EU] g.i GscfridUdYf %\$\$ k cfXgžZYYXV**%**W_dfcj]XYX Vmih fb]h]b%o

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

5ggYgga Ybh&; fci d k cf_dfYgYbhJhcb

GhUfhXUhY. Bch5dd`]WUV`Y

 GHJfhXUhY. Bch5dd`]WUV`Y

 $@Yb[h\.^{\cdot}\&) $$^{\cdot}k \ cfXg \ fbch]bWi \ X]b[\ ^{\cdot}fYZ \ fYbW \ g \ ^{\cdot}UbX \ ^{\cdot}V]V \]c[\ fUd\ ^{n}k]$

8YHJ]`g. ^&) \$\$ 'k cfXgž'ZYYXVUW_ dfcj]XYX Vm'hi fb]hjb"

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

1	

FYgci fW/g

DfYgWf]VYX F Ygci fWyg

FYWca a YbXYX FYgci fW/g

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

Gh XYbhZYXVUW_']g'_YYb`mfYei YghYX'hc'U``ck 'Z fh\Yf'Z]bY!h b]b['UbX']a dfcj Ya Ybhg']b'Z h fY'mYUfg" : cfa U``a m9I dYf]YbW' Yj U`i Uh]cbg'k]```VY'i gYX'Uhh\Y'YbX'cZgYa YghYf'Vi hgh XYbhg'UfY'YbWti fU[YX'hc dfcj]XY'ZYYXVUW_'h\fci [\ci hh\Y'gYa YghYf'cb'Wti fgY'WtbhYbhUbX'Ugg][ba Ybhg'Ug'k Y```Ug'h\Y'dUW]b['cZ

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

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'YI 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\"'=\maintention
UfY'i bUV'Y 'rc'gi Va]hmci f'Ugg][ba YbhXi Y 'rc'U'\ZUi 'hk]h\'Hi fb]r]b'mci 'a Um'Udd'm\Zcf'Ub'YI hYbg]cb\ZVi hmci
a i ghfYhU]b'mci f'r]\W_Yhbi a VYf\Zfca '9I hYfbU''Gi ddcfhfU'cb['k]h\'Ubmch\Yf'fY'Yj UbhXcW a Ybfg\L'rc
]bWi XY'Ug'Yj]XYbWY 'rc'gi ddcfhmci f'YI hYbg]cb'Udd']\WUh]cb'''=\maintention
UfY'' bUYY''mfYWY']j Y'U'r]\W_Yhbi a VYf\ZVi h']Zmci 'hY'Yd\cbY'mci 'k]'''bYYX'rc'gdYW]\Z\WU'`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 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'\\ci fgY'g'A ccX`Y'g]hY'k]h\ U`hYfbUh]j Y'gi Va]gg]cb'XYhJ]`g''

cfi]bZcfa Uh]cbicbi\ckihcigi Va]hUgg][ba Ybhgicbi]bYij]UiA ccXiY.i\hdg.#gh XYbh'i bgk "YXi "Ui #\ck! qi Va]hUgq][ba Ybha ccXiY

5 WUXYa]W<cbYghmUbX 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'

IBGK [fcidg'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`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 cghmfYhU]b]b['h\Y'cf][]bU`ghi 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 h'WfYX]h'UbX'hc d]YW]b['hc[Yh\Yf'ei chYg'UbX'dUfUd\fUgYg']bhc'U'bYk'k\c`Yžk]h\ci h'Uddfcdf]UhY'fYZYfYbW]b['"

7 c``i g]cb.'k cf_jb['k]h\ch\Yfg'Vi hdUgg]b['cZZh\Y'k cf_'Ug'U'dYfgcb'g']bX]j]Xi U``k cf_"'7 c``i g]cb'U`gc]bWi XYg'dfcj]X]b['mci f'k cf_'hc'Ubch\Yf'ghi XYbhVYZcfY'h\Y'Xi Y'XUhYžcf'Zcf'h\Y'di fdcgY'cZh\Ya d`U[]Uf]g]b['UhiUbmh]a Yž'dUm]b['Ubch\Yf'dYfgcb'hc'dYfZcfa 'Ub'UWUXYa]WhUg_ž'ghYU']b['cf'UWei]f]b[Ubch\Yf'dYfgcb'g'UWUXYa]Wk cf_'UbX'Wcdm]b[']hz'cZYf]b['hc'Wca d'YhY'Ubch\Yf'dYfgcb'g'k cf_'cf'gYY_]b[dUma YbhZcf'Wca d'Yh]b['UWUXYa]Wk cf_"

±bUddfcdf]UhY`W]hUh]cb.`7]h]b[`gcifWrg`k\]W\`\UjY`bchVYYb`fYUXžk]h\cihUW_bck`YX[]b[`h\Y`´gYWcbXUfm´gcifWrZfca`k\]W\`_bck`YX[Y`cZh\Ya`\Ug`VYYb`cVhU]bYX"

8 i d`]\WUh]cb`ffgY`Zd`U[]\Uf]ga "Ł gi Va]\h]b[`mci f`ck b`k cf_ž]b`k \c`Y`cf`]b`dUfhžk \YfY`]h\Ug`dfYj]ci g`m VYYb`dfYdUfYX`cf`gi Va]\hYX`Zcf`Ubch\Yf`UggYgga Ybhcf\Wci fgY`UhI BGK `cf`Ubch\Yf`i b]j Yfg]\m'

7 cffYWnfYZYfYbWlb['dfUWnWyg.

• DUfUd\fug]b[z'gi a a Uf]q]b[z'YggUmk f]hb['UbX'ha Y'a UbU[Ya Ybh

- i bXYfgHUbX'mci f'f][\hg'UbX'fYgdcbg]V]`]h]Yg'Ug'U'gh XYbhUhI BGK
 VY'Uk UfY'cZd`U[]Uf]ga ž'Wcdmf][\hz'I BGK 'Gh XYbh7cXY'cZ7cbXi WhUbX'5VWWdhUV`Y'I gY'cZ IBGK =7 HF Ygci fWrg Dc`]Wh

5 WUXYa]W = b Zcfa Uh cb.

: 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[Yg/
- YI Ua]bUhcb dfcWXi fYg/
- gdYWJU``Wcbg]XYfUHjcb`]b`H\Y`Yj YbhcZ]``bYgg`cf`a]gUXj Ybhi fY/
- gh XYbhYei]mUbX X]gUV]`]m/
- UbX'ch\Yf'YggYbhJU`'UWUXYa]W']bZcfa UhJcbž'gYY

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

∍a U[Y'7fYX]h

Gc`c'DYfZcfa UbWY'A U_]b['&\$%

7F = 7CG

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