

!!!" #\$\$%&' (!)%*+!, *-&\$.!
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!/01!

!!, *-&\$.!*2!3\$(45(6!7/8!/977!

!;#' <#6.!7=8!/971!

!

>' ?6*@\$?&*': 1!

)(?\$&*' !A:!)%*+!B6C#' &D#?&*' !#' @!E<66(' ?!F(G* <6\$(G 2!

709!, (6G*' ' (-H<' \$?&*' G!E* 4 4 *' !?#!A--!)%*+!)?#22J 2!

!

70 T(' (6#-!*+(6#?&* G&!' 26#G?6<\$?<6(8!#' @!X*6[!#GG&C' 4 (' ?!&' !?%(!' #\$\$%&' &' C!H#\$&-&?. 0!!
/0 , 6*S(\$?!4#' #C(4 (' ?!%6* <C%!#\$\$(+?#' \$(!#' @!#++6*\#-!*2!, 6*S(\$?!F (] <(G?!H*64!!H/J8!\$*G?!
] <*?#?&* G&X*6[!@&G?6&5<?&* 8!4#&' ?(' #' \$(!*2!%(!] <(<(8!\$* 4 4 <' &\$#?&* !X&?!?%(!\$-&' ?!
#' @!G<5 4&??&' C!\$* 4 +-(?(@!, 6*S(\$?!F (] <(G?!#' @!E%#6C(!Q#[\$!H*64!!H=J!?!L" 0!!
K0 A\$?&' C!#G!7%(!' #\$\$%&' (!)%*+!)#2(? . !E**6@&' #?*68!+6*\&&' C!6#&' &' C!G(GG&* ' G!?!G?<@(' ?G!*' !
G#2(!#' @!\$*66(\$?!<G(!*2!I (] <&+4 (' ?!&' J!%(!)%*+8!#' @!*' !#*&@&' C!%#D#6@G0!
M0 P+@#?&' C!#!G(?!*2!X6&??(' !' (\$%!U' C&' ((6&' C! b)#2(!#' @!U22&\$&' ?!)%*+!B+(6#?&' C!, 6*\$(@<6(Gc!
I)U)B, J!2*6!7%(!<G(!*2!?* *-G!#' @!4#\$\$%&' (6. 8!#' @!*5G(6\&' C!?!%#?!?%(!X*6[!&' !?%(!)%*+!&G!@*' (!
#\$\$*6@&' C!?!?%(40!
N0 E*' G<-?#?&* !X&?!C6#@!G?<@(' ?G!#' @!2#\$<-?. !*' !+6*S(\$?!@ (G&C' !&GG<(G0!
O0

70 P' @ (6C6#@<#?(!G?<@(' ?G!\$#' !<G(!?%(!Q79K!" #\$\$%&' (!)%*+!&' !*6@(6!?*!\$* 4+- (?(!\$* <6G(!X*6[!
 #G!6[] <&6(@!&' !?%(&6!\$* <6G(!* <?-&' (8!2*6!" UER!/998!KN98!M998!#' @!Q" U!KN98!
 /0 >' !*6@(6!?*!\$#66. !* <?!G<\$%!X*6[8!7%(!" #\$\$%&' (!)%*+!&G!#\#&-#5-(!#?!?%(!2*--*X&' C!?!&4 (G:!
 !

Y(64G!	3#?(!:	E* <6G(G!) (GG&* ' !A!) (GG&* ' !Q!
) +6&' C!	H(5!IX(([G:!/8!K!Z!M!	KN98!M99!		
) +6&' C!	" #6\$%!IX(([G:!/78!/8!K8!Z!M!	KN98!M99!		
) <4 4 (6!	; <' (!IX(([G:!/8!K!Z!M!	M99!		
) <4 4 (6!				

Y%(!" #\$\$%&' (!)%* +!17J!&' !Q79K!\$#' !5(!<G(@!#2?(6!6(C<-#6!X*6[&' C!%*<6G!<' ?&-!79:K9!+48!5.!

10 , (6G*' #-!\$*' 26*' ?#?&*' !G%* <-@!5 (!#\ *&@(@!#?!#--!?!&4 (G0!>' ?(6W+ (6G*' #-!&GG< (G!4 <G?!5 (!
@*\$<4 (' ?(@!&' !X6&?&' C!#' @!G<5 4&??(@!?'!?!%(!E%#&6&!X%*!4#. !#?!%&Gd%(6!@&G\$6(?&' !@&6(\$?!
?%(4!?'!RF0!

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H/J!" (\$%!, 6*S(\$?!F"]<(G?dE%#6C(!H*64!

HKJ!A2?(6WR* <6G!" (\$%!)%*+!)<+(6PG(6!!!!

HMJ!)<+(6PG(6!Ue+(6&(' \$(!H*64!

H=J!E*' G<4 #5-(G!E%#6C(WQ#\$[!L *C!

!

H7J!" (\$%!)%*+!U]<&+4 (' ?!)&C' WB<?!L *C!>' ?(6' #-J!

HNJ!" (\$%!)%*+!` *6[!L *C!>' ?(6' #-J!

HOJ!" (\$%!)%*+!PG(!H*64!>' ?(6' #-J!

H1J!" (\$%!)%*+!` *6[!F<(<(!)%((?!>' ?(6' #-J!

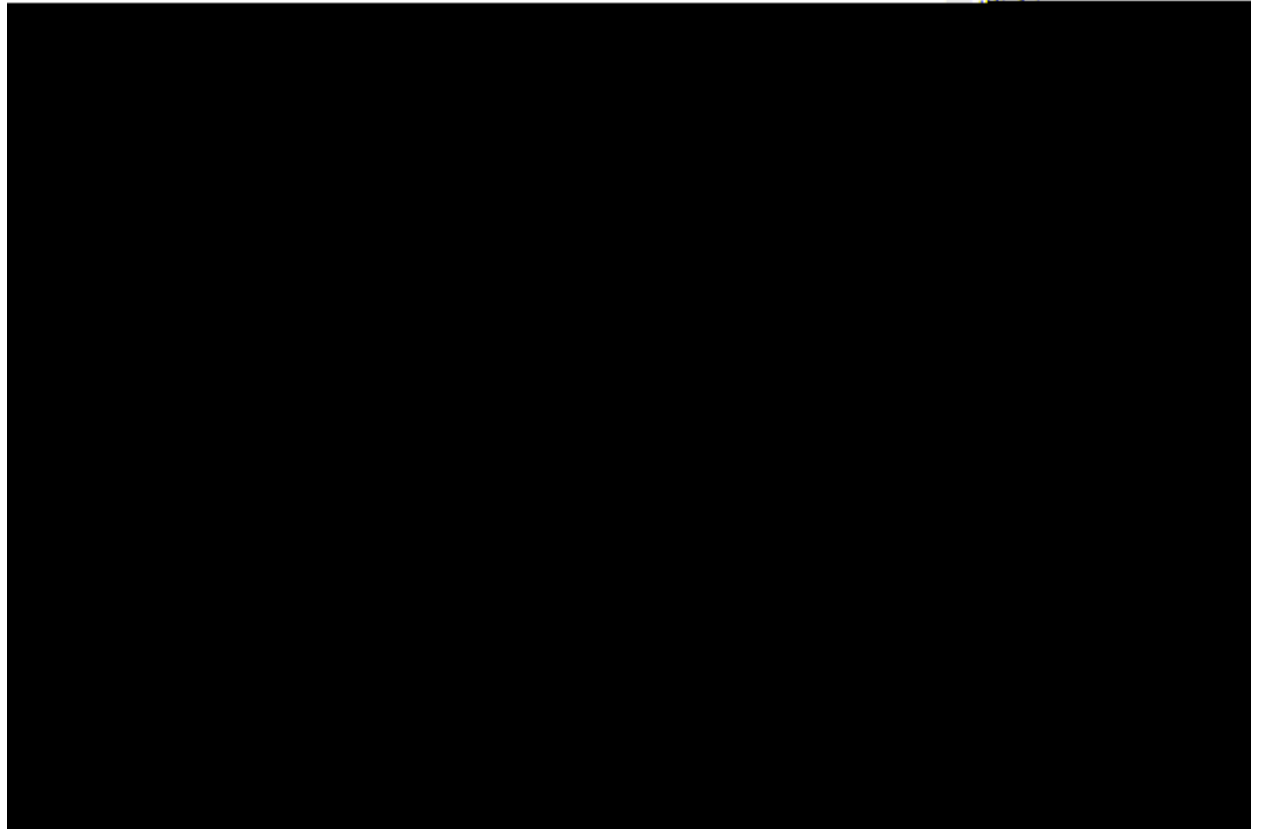
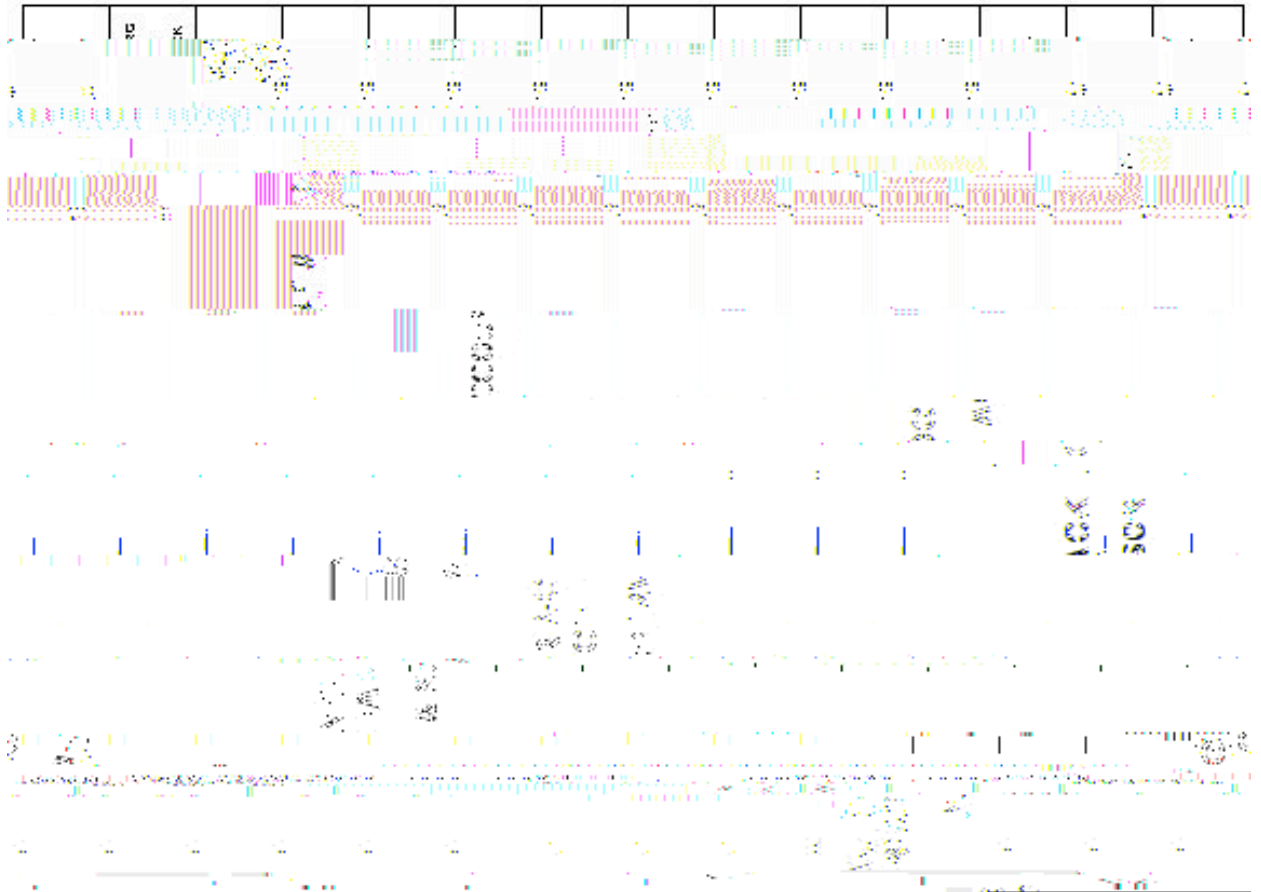
!

A++(' @&e!A:!)#4+-(!)%*+!@6#X&' C!!

Department of Mechanical Engineering

H=I!E*! G<4#5-(G!E%#6C(WQ#\$\$[!L*C!

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