

5HSRUW 1R 1&3 53
5HSRUW 'DWH 0DUFK

5HY 1

6ROYD\)RUPHUO\ \$GYDQFHG &R
070 &) 5: . 3: \$6)DEULF
FXUH F\FOH FRPSDUHG WR 0+
(TXLYDOHQF\ 6WDWLVLWLFDO \$

)\$\$ 6SHFLDO 3URMHFW 1XPEHU 63 : , 4

1&\$03 'RFXPHQW 1&3 53 5HY 1 &

5HSRUW 'DWH 0DUFK

(OL]DEHWK &ODUNVRQ 3K '

1DWLRQDO &HQWHUWRULSDO QFHGRUDDQFH 1&\$03
1DWLRQDO ,QVWLWXWH IRU \$YLDWLRQ 5HVHDUFK
:LFKLWD 6WDWH 8QLYHUVLW\
:LFKLWD .6

7HVWLQJ)DFLOLW\
6ROYD\)RUPHUO\ \$GYDQFHG &RPSRVLWHV *URXS

6RXWK WK (DVW \$YHQXH
7XOVD 2.

7HVW 3DQHO)DEULFDWLRQ)DFLOLW\
6ROYD\)RUPHUO\ \$GYDQFHG &RPSRVLWHV *URXS

6RXWK WK (DVW \$YHQXH
7XOVD 2.

'LVWULEXWLRQ 6SRWHQWLQWR \$ SXEOLF UHOHDVH GLVWU

5HSRUW 1R 3 1&3 5 5HY 1 &
5HSRUW 'DWH 0DUFK

3UHSDUHG E\

(OL]DEHWK &ODUNVRQ

5HYLHZHG E\

-RQDWKDQ 7LVDFN

.DWKHUL

\$SSURYHG E\

5R\DO /RYLQJIRVV

7\$%/(2) &217(176

,QWURGXFWLRQ

6\PEROV DQG \$EEUHYLDWLRQV

%DFNJURXQG

5HVXOWV &RGHV

(TXLYDOHQF\ &RPSXWDWLRQV

+ \SRWKHVLV 7HVWLQJ

7\SH , DQG 7\SH ,, (UURUV

&XPXODWLYH (UURU 3UREDELOLW\

6WUHQJWK DQG 0RGXOXV 7HVWV

0RGLLHG &RHIILFLHQW RI 9DULDWLRQ

(TXLYDOHQF\ 7HVW 5HVXOWV

:DUS &RPSUHVVLRQ :&

:DUS 7HQVLRQ :7

)LOO &RPSUHVVLRQ)&

)LOO 7HQVLRQ)7

/DPLQD 6KRUW %HDP 6WUHQJWK 6%6

,Q 3ODQH 6KHDU ,36

3 2SHQ +ROH 7HQVLRQ 2+7

3 2SHQ +ROH &RPSUHVVLRQ 2+&

,QWHUODPLQDU 7HQVLRQ ,/7 DQG &XUYHG %HDP 6WUH

&RPSUHVVLRQ \$IWHU ,PSDFW &\$,

&XUHG 3O\ 7KLFNQHV &37

6XPPDU\ RI 5HVXOWV

7KH DVVXPSWLRQ RI ,QGHSHQGHHQH

)DLOXUHV

3DVV 5DWH

3UREDELOLW\ RI)DLOXUHV

5HIHUHQFH

/LVW RI 7DEOHV

7DEOH 7HWW \$EUBHHDQV
 7DEOH (QYLURQH VMDOV & \$EEUHYLDWLRQV
 7DEOH 2QH VLG HFGWR B O H B D CQFLP LDV VYDQ XHVP SOH PHDQ
 7DEOH 2QH VLG HFGWR B O H B D CQFLP LDV X R Q Y D O R S O H P L Q L
 7DEOH)DLOXHG W V 6 F D O H
 7DEOH 6XPPDUORQ FT XLYWDV 5HVXOWV
 7DEOH : D U S V & R P S U H Q J W K 5 H V X O W V
 7DEOH : D U S V & R P S U H Q J W K 5 H V X O W V
 7DEOH : D U S V & R P S U H Q J W K 5 H V X O W V
 7DEOH : D U S V & R P S U H Q J W K 5 H V X O W V
 7DEOH : D U S V & R P S U H Q J W K 5 H V X O W V
 7DEOH) L O O & R P S U H Q J W K 5 H V X O W V
 7DEOH) L O O & R P S U H Q J W K 5 H V X O W V
 7DEOH) L O O 6 H Q V I R P X P V H D Q G (T X L Y D O H Q F H O L P
 7DEOH) L O O 7 H Q V I R P X P V H D Q G (T X L Y D O H Q F H O L P
 7DEOH / D P L Q D 6 K R Q U W % P B D G W U P L Q L P D X P H Q F B G O (P X L W V
 7DEOH , Q K 3 O D Q H 6 Q H D X P P H D Q G (P X L Y D O H Q F H O L P L W
 7DEOH , Q K 3 O D Q H 6 Q H D X P P H D Q G (P X L Y D O H Q F H O L P L W
 7DEOH 2 S H Q + R O H D Q M Q F L R Q P X P V D Q G (P X L Y D O H Q F H O L
 7DEOH 2 S H Q + R O H D Q M Q F L R Q P X P V D Q G (P X L Y D O H Q F H O L
 7DEOH , Q W H U B Q P L Q G & X H Q N G % H D P 6 P L Q H L Q X W K B G Q V
 7DEOH & R P S U H , P S I D F Q \$ I W H D Q V P L Q L Y P X P H Q F B G O (P X L W V
 7DEOH & X 7 K L G B O H V V 5 H V X O W V

/LVW RI)LJXUHV

)LJXUH DCSH 7, \SHU, R UH
)LJXUH 6XPPDU\ RH DQWU B Q G W P K L Q L P X P V K F R B S U H V H S H F W R L W H
 (TXLYDHO HQ PLWV
)LJXUH 6XPPDU\ RI 37GRB D Q V D Q G G (TXLW DOHQFH OLP
)LJXUH : D U S & R P S U H Q J W V E R Q L P X P V D Q G (P X L Y D O H Q F H O L P
)LJXUH : D U S 7 H Q V I R P X P V H D Q G (P X L Y D O H Q F H O L P L W V
)LJXUH) L O O & R P S U H Q J W V I R P X P V H D Q G (T X L Y D O H Q F H O L P
)LJXUH) L O O 7 H Q V I R P X P V H D Q G (P X L Y D O H Q F H O L P L W V
)LJXUH / D P L Q D 6 K R Q U W % P B D G W U P L Q L P D X P H Q F B G O (P X L W V
)LJXUH , Q 3 O D Q H 6 Q H D X P P H D Q G (P X L Y D O H Q F H O L P L W
)LJXUH 2 S H Q + R O H D Q M Q F L R Q P X P V D Q G (P X L Y D O H Q F H O L
)LJXUH 2 S H Q + R O H D Q M Q F L R Q P X P V D Q G (P X L Y D O H Q F H O L
)LJXUH , Q W H U B Q P L Q G & X H Q N G % H D P 6 P L Q H L Q X W K B G Q V
 (TXLYDHO HQ PLWV
)LJXUH & R P S U H , P S I D F Q \$ I W H D Q V P L Q L Y P X P H Q F B G O (P X L W V
)LJXUH & 37 P H D Q V G H U W R D Q G S D W V D Q G Q R P L Q D O Y D O X
)LJXUH 3 U R E I D X P I E C H L W R I R) D L O X U H V

,QWURGXFWRQ

7KLV UHSRUW FRQVWDHQW WKH WRTXNDXOIRVFRUO\ \$GYDQFHG
&RPSRVLWHV *URXS 070 5: &). 3: \$6)DEULXUFDFFOH
FRPSDUHG WFDWFKDROUJLFDWLRQ SDQH00+ SERGXFFH6OXVLRQJ
VDPH PDWHULDO 7KHQDWPILQDWHQJL DODS/HRISHUQ\J3QWDDKWH
ZLWK)\$\$ RYHUVLJKVSHFKDQX3KR)S\$FW 1X4P8QG 030VR: ,PHHW
WKH UHTXLUHPHQW 03R6WDDQGLGLQSHUSDW63J 3URKHHGXUHW
SDQH0V WHVW VSHFLPHQV DQG WHVWKHVY\$\$DQGWHKEIHHG
WHVWLQJ KDWVHGHQEZWKQH)\$\$

7KH PDWHULDO ZDV* SODRFXWHDGOV6S \$LILFDW5RQLS&*RQ , 5
GDWHG -DQXDU\ HQ\$Q1 &STX3 PDW HULFD 106HFLILFDW
EHHQ FUHDWHG 106 SHFLRFDWDLRQ/ QHPLWVHGVKDRP DUKH
TXDOLILFDWLRQJDXMDGHQV QHV LQ V\$5WLRQDQRGI &27)\$\$
9ROXPH 5HY * VHFWRQ

7KH PHFKDQLFDO WHVWVQEI\ ZDV DMUWRKHLPDXDFD02M0 7KH
FRPSDULVRQV ZHUH SHQJIRUP &G+DFFRUGHFKLHRQRGLILHG
FRHILFLHQW RI YDUFRPSDULVRQGW80V D7FZHG-DGRQZLLQK
VHFWRQ RI &0+WHV'W'GDWD ZDV DRWHDXDYDDEQF\IRU
FRPSDULVRQ

7KH RULJLQDOLRXDGDMD 3DLQ30Z0LVK&)DWD 0+ &XUH &\FOH
9DOXH 2QO\ SGLILFDWLRQ WHEULSDWHGVLQHDFFRDGD
ZLWK 6ROYD\ IRUP880S\$6YDQVHGRXSLSDWERQV\$8SHFLI
5HYLVLRQ (30+'FKHHFXFD0HQF\ GHGDQZD07\$XEOLVK
&) 'DWD 0 &XUH &\RQD09DOXHVSGL' 7KHVZHHVM \$DEULFDW
LQ DFFRUGDQFH ZLW\$H\$&FLSDRWRQV\$8*3LRQ (30HYFLXUH
F\FOH

(QJLQHHULQJ EDVLSYRUQXHG/ LZHU & \$03 5HSRUW 11 & 3 53
ZKLFK GHWDQGDWKH DQV PHWKRGRORJDXVMGYDQXHFVDSXZ/H
DV SURYLGLQJ WKHQGSDVLDQGLYDQXHWFRPSRPHWKH WHVWUH
IRU WKH RULJLQDOLRXD SDQH0V

7KH 1&\$03 VKDUHG PDWGHULD DSD/HRISHUQWDRSHUFDVGHUWLDQRIS
FRPPRQ XVHIXOQHVV WIRDDIRGSDIDFBIQSIRUMHFKVHGBRZHPB\Q
IXOIL00 DOO WKH 6SH6VIIRF SUSRSHUMLV 8QFLQBWH DUFK
DQG ORDGLQJ VLWYLDXDRQSURMDFWLVQGLGLWDRQDQXLVVWL

\$LUFUDIW FRPSDQLHV VKRXOG QRW SRHWWZHVGKDRKDV SXSEFLM
1&\$03 0DWHULDO 6SHFLILFDWLRQ 1KDV DGLHTXLLRQHPHQWV
DUH OLVWHG LQ LVVFBQMSURHJ SRJRFHM SMFL3&FDWILRQU ILEHU
DQG RWKHU UZ PDLRQVLDQGV\$&FLZKFDKQWLSROVFXHVOVW\FR

RQ WKH Udz PDWHULW B O V D D Q E D Q X Z D F W X Q L S U R H F A X W S F M Q W D
 companies and certifying agencies should assume that the material property data
 published in this report is not applicable when the material is not procured to NCAMP
 Material Specification NMS 451/7 106 LV D IUHH SXEOLFO\ DYDLODE
 SURSULHWDU\ DHURVSDFH LQG X VWU\ PDWHULDO VSHFLILFD

7KH XVH RI 1 & \$ 03 P D W H U L W D O S H Q F E I S E D W K L R U D Q Q W R I H I V P Q R M M W L D
 VWUXFWXUDO SHUIRUPDQFH DQG TXDOLWV Q R M Q E D R G V E B H W R O S H U S I R W P K D V H U
 TXDOLW\ FRQWUROU S H U W R G L S H H T R U L P I D O M Q V W D G G L S D L R Q L F L S
 PDWHULDO FKDQJH P L G D J H F R I Q Q W F D W L Q L Y W W D W L R Q W E B O S D Q
 FRQGXFWLQJ UHJXODU VXSSOLHU DXGLWV

7KH DSSOLFDELOLWY & \$ 03 D E F X H U L D O R S E B S H H W W D G D W D R Z D E
 DQG VSHFLILFDWLRQHGPRQW F E V H H E Y D F O W H F E D V W V F R P S D Q L H V
 FHUWLI\LQJ DJHQFLHV 1 & \$ 03 D E V Q P W \ U Z H K D M G R I Y H U S E L S H G
 UHODWHG WR WKH D X V S I U R I S W K W \ P G D W D E L O P H W D I Q G D O S E E I O I R F D V

6\PEROV DQG \$EEUHYLDWLRQV

7HVW 3URSHUW\	\$EEUHYLDWLRQ
:DUS &RPSUHVV\LRQ	:&



7\SH , DQG 7\SH , , (UURUV

	<i>Materials are equal</i>	<i>Materials are not equal</i>
<i>Conclude materials are equal</i>	<i>Correct Decision</i>	<i>Type II error</i>
<i>Conclude materials are not equal</i>	<i>Type I error</i>	<i>Correct Decision</i>

)LJXUH 7\SH , DQG 7\SH , , HUURUV

\$V LOOXVWUDWHG HLUH)LJXUH XU SRVWLZROFRXUMIFRVPFRQFOX
 DQG WZR HUURQRXV FRQFOXVLRQV 7KHVHZR\SHR,QDQFRWR
 ,, HUURUV WR GLVWLSUREDELOLWZRZHPDNRQLDWSBFLILHG
 SDUDPHWHU BDOOHZGLDHSWKHW\SHO\,FRUPSRXUHVQRUFRQWU
 7KHWHUP μ VXILFLHQWOMKXQYLNHXOYSLLQDPRD\$KSPHDFQVH
 WHUPLQRORJ\WKHSURPESXELHOGWHRHWWKDWLW\KLPFSWQ&QR
 QXOO K\SRWKHVLV LV OHVV WKDQ .

)RU HTXLYDOHQF\ WHLWHLQDWRHFRPSRZKLFK VFRWUDHW SRQGV
 FRQILGHQFH OHYHODRIVWKDKLVIPZH DQGMEDW WKKHVOXROEDWH
 DUHQRW HTXLYDOHQF\ZLSDKUWHVSEEDLWHWKKDWKWKSLURED
 GHFLVLRQLVQR OHVV WKDQ

&XPXODWLYH (UURU 3UREDELOLW\

(DFKFKDUDFWHU\LRQVILFWXGLFKDDV7HQQLRQDQWU6KHJDUKPRIGXO
 LVWHVWHG VHSLSUREDELOLWHRWVHWKSHV,DFHURU DOO WH
 PDQ\GLIIHUHQW WHVRODUHLQHOHRPDKULDOSWREBEZOLWV
 W\SH , HUURU WKKHSLURJEBEHORW\PRUMHDLØXURHWIHO\WVFD
 PXFK KLJKHU

,I ZH DVVXPH WKHWHZRGPHQWHLLFDDO VZHDVSKIRAEZREMOHLWWVVRWVW
 HUURU IRU WKFRVEZLRQWGLVW í)RU IRXUWWH\LVHW WR í
)RU WHVWVWWKHSURPESDEJOPURUHWUHQVWRULV í

0DUFK

3&3 5

5HY 1 &

0DUFK

1&3 53

5HY 1 &

0DUFK

1&3 53

5HY 1 &

7KLV LV FRQYH\WPH\SWUSO\LQJ E\

&9 LV XVHG WR FRPLXWH DWFQGDUG GHYLDWLRQ 6

$$S \quad CV \quad \bar{X}$$

7R FRPSXWH WKH SRRLDGLRQ EDV DUGGRQH WKH PRGLLHG

$$S_p \sqrt{\frac{\sum_{i=1}^k n_i CV_i \bar{X}_i}{\sum_{i=1}^k n_i}}$$

(TXDWLRQ

7KH \$ EDVLV DQG %X EDVILUVWKH DNV XP SWHRSQ&R IPM WKH RQ DLH
FRPSXWHGDELQHSOZLWK 6

:KHQ WKH EDVLV YDOXH V KDYH EHHQ VH

(TXLYDOHQF\ 7HVW 5HVXOWV

7KHUH ZHUH D WRH... WR WKH UHFRPPHQGDWLRQ... ZLWK LQVXILFLHQW... \$OO WHVWV ZHZLW\$HQQR.UOHCHO RI

7KH UHVXOWV RI WKH... &9 μ3DVV ZLWK ORG... FRHIILFLHQW RI YDU... SDQHOB DQG SURFH... VSHFLPHQV IRU PRGXO... RI VSHFLPHQV WK... LQGLFDWLRQ \$ V... LQ 7DEOH

)DLOXUHV LQDT... E\ WDNLQJ WKH UDO... IRU WKDW YDOXH D7... IDLO

'HVFULSWLRQ	ORGXOXV	6WUHQJWK
0LOG)DLOXUH	IDLO "	IDLO "
0LOG WR ORGHUDWH)DLOXUH	IDLO "	IDLO "
ORGHUDWH)DLOXUH	" IDLO	" IDLO
ORGHUDWH WR 6HYHUH)DLOXUH	IDLO XUH	IDLO "
6HYHUH)DLOXUH	IDLO "	IDLO
([WUHPH)DLOXUH	IDLO	IDLO

7DEOH)DLOHG 5HVXOWV 6FDOH

0DUFK

3&3 5 5HY 1 &

(TXLYDOHQF\ 7HVW 5HVXOWV IRU 6ROYDM *JRXPSHUO\&XGHDQFHGH&RPF
ZLWK 070 &) 5: . 3: \$6)DEULF 0+ &XUH &\FOH

7BD@(0

1RUPPHVJHG 6WUHQJWK@C8C.FTE
3HWYq(de1, DUP, DAgA <WAUS* & JUF, eHQ'115D' ARQ
DWDTRP Dh&Dp &7' 57' (7' (7:

6WUHQJWK)DLOHG E\ 3DVV

0RGXOXV 3DVV 3DVV

6WUHQJWK 3DVV 3DVV

0RGXOXV 3DVV 3DVV ZLWK
ORG &9

6WUHQJWK)DLOHG E\ 3DVV 3DVV

0RGXOXV 3DVV)DLOHG E\ DLOHG E\

6WUHQJWK 3DVV 3DVV ,QVXIILFLHQW
'DWD

0RGXOXV)DLOHG E\ DLOHG E\)DLOHG E\

2IIVHW 3DVV
6WUHQJWK QVXIILFLHQW
'DWD

6WUDLQ 3DVV
6WUHQJWK

0RGXOXV 3DVV)DLOHG E\

6KRUW %HDP 1R 6WUHQJWK)DLOHG E\ 3DVV ZLWK
ORG &9

2SHQ +ROH <HV &RPSUHVVLQR 6WUHQJWK 3DVV 3DVV ZLWK
ORG &9 ,QVXIILFLHQW
'DWD

2SHQ +ROH <HV 7HQVLRQ 6WUHQJWK 3DVV ,QVXIILFLHQW
'DWD

,QWHUODPLQDU 1R 7HQVLRQ 6WUHQJWK 3DVV ,QVXIILFLHQW
'DWD

&XUYHG %HDP 1R 6WUHQJWK 3DVV ,QVXIILFLHQW
'DWD

&RPSUHVVLQR <HV \$IWHU ,PSDFW 6WUHQJWK 3DVV ,QVXIILFLHQW
'DWD

&XUHG 30\ 1\$ 7KLFNQHV 1\$ 1\$

0DUFK

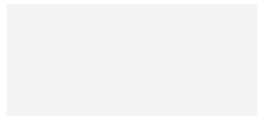
1&3 53

5HY 1 &

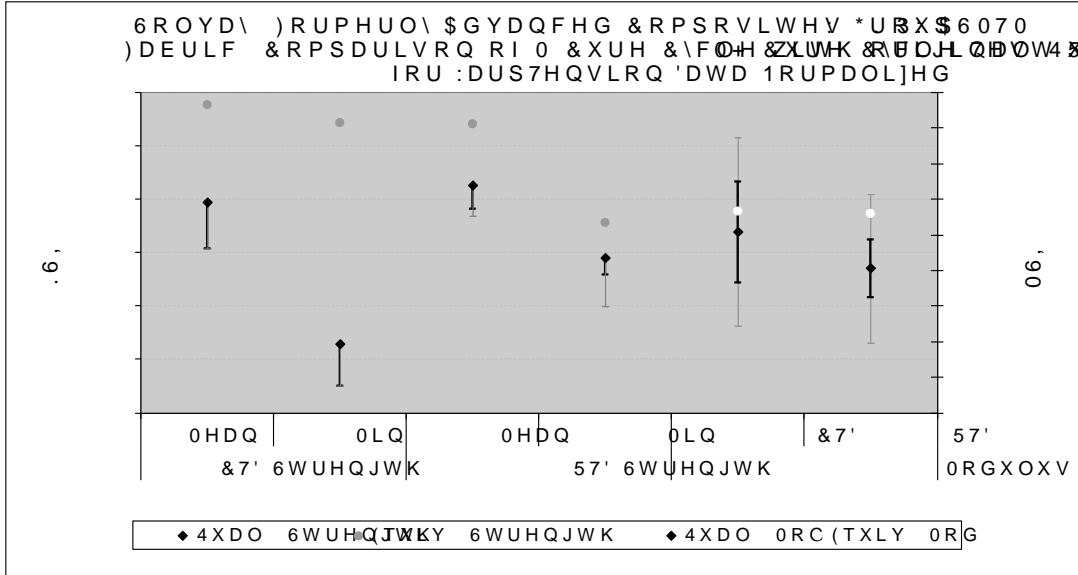
:DUS 7HQVLRQ :7

7KH :DUS 7HQVLRQ GDWD LV QRUPDOLJHG CER UFXDOLJHG GVVW
SDVVHG DOO HTXLYDOHQF\ DQG V\ 'IRRGXUW LVRQH\ DRUPDOLJH
PRGXOXV GDWD LQ WKHTXLYDOHQF\ UFRQGLXWHG R9WPKHWK RGLWR S
HTXLYDOHQF\ ORGLZHUH &ORUHS XE WLVGHWU HRUJWK E &W'D EHF
WKH FRHIILFLHQW RIEYULDVZKR EKZ B HFRQLMLK E W & W KH V X O W
ZHUH QR GLIIHUHQW JURRZ KH 6 WDXV LV WULFWX D Q G D Q B O X K R
WKH VWUHQJWK E B D W D D Q R T B X O W K H G D W D L Q 7 D E O

4XDO (TXLY 4XDO (TXLY
'DWD QRUPDOLJHG ZLWK &37
0HDQ 6WUHQJWK NVL
6WDQGDUG 'HYLDWLRQ



)LJXUH LOOXVWULRQ HWWWKHQJWKPHDQVDOXQGVPLQGPKKH
 PRGXOXV PHDQV IRBQWKBIPTXCHODIQGDMWLBHSTOHL YDIOHHOFLPLWV
 HTXLYDOHQF\ VDP SOHJUDBH EEBZQZDWKQWGBWTDX DOKHLGBWJH
 OLJKWHU FRORUHGUHWKURBREGLU VHDGU&9IRRPSXWDWLRQV



)LJXUH :DUS 7HQVLRQ RRGXPHDQGVHTXLYDOHQFH OLPL

)LOO &RPSUHVLRQ)&

7KH)LOO &RPSUHVVRBQLGHDV\LFXQRIG7&B\WQLFWRDHOV\JHG
 VWUHQJWK GDWD SDWVHG IRTUXWYKHO(HQDLQWLRQVFRXQG QRW W
 57' FRQGLWLRQ 7KHIG) & QRUPSDVGDHGTXWYDOWHQ RQO\ IRU
 57' FRQGLWLRQ QRW (R:UFWRIGLWLRQVUHVRGMVHZH&B QRW
 SURYLGHG HQWVWKIGDWDV EHFDXVH LQHQDQV RFDYBVLVWVHLFRHZI
 DERYH ZKLFK PHDQVLMIGD&B WKNXPORVGHZQW HURR QVLIHUV
 VKRZQ 6WDWLWVLFVQVQGDQDQVZQVLRUGXWHDVQVHDEOH
 IRU WKH PRGXOXVDEOW

)LOO &RPSUHVLRQ	57' 6WUHQJWK 4XDO (TXLY	(7' 4XDO	(7: 4XDO (TXLY	4XDO (TXLY
'DWD QRUPDOLJHG ZLWK &37 0HDQ 6WUHQJWK NVL 6WDQGDUG 'HYLDWLRQ &RHILFLHQW RI 9DULDWLRQ 0LQLXP 0DLPXP 1XPEHU RI 6SHFLPHQV				
5(68/76		3\$66	3\$66	
0LQLXP \$FFHSWDEOH (TXLY 6DPSOH 0HDQ				
0LQLXP \$FFHSWDEOH (TXLY 6DPSOH 0LQ				

7DEOH)LOO &RPSUHVLRQ 6WUHQJWK 5HVX

4XDO (TXLY 4XDO (TXLY 4XDO (TXLY
 'DWD QRUPDOLJHG ZLWK &37
 0H GgT• P# XQRg!7bIFeFi0 @ • TeQ! UFeFi0)@ 0 @• °

0DUFK

1&3 53

5HY 1 &

7KH)& PRGXOXV GDWYRURQPHQW IDLOHGWKHW HETHKLDYDOH
VDPSOH PHDQ YDOXHH WKH XSDHURDFFHSWDQRH OLPLW

0DUFK

1&3 53

5HY 1 &

)LOO 7HQVLRQ)7

7KH)LOO 7HQVLRQ HGDWDFXUQBUSPOOMJLGRQPIDOLJHGHVWUH
GDWD SDVVHG HTXLYDQWQWKWHHVWR7KBLWLRQRUPVHDLVHGG
PRGXOXV GDWD GLGHQFWSDVWVHTXUHDORQG LWKLRQKWHVWH
WKUHH FDVHV GXH MRDQKHPRGXRVRKJJKHVXROGLMLZHUQRV
SURYLGHG IRU WKHH&7'WKUG(DWDVEUHFDXWHRWKYDDBDWLRQHZD
DERYH ZKLFK PHDQG LWKHGV&0KUHPRXOVMQZHIURQRVSHIUV
VKRZQ 7KHUH ZHUSHIFQPHIQMFILEQWKH DWDVWRUHQJMKUGVXOV
EH FRQVLGHUHG FRVEXVLDYGDQDOWLRZQUHVKOMKH DWHUHQJ
LQ 7DEOH DQG IRU WKH PRGXO

0DUFK

1&3 53

5HY 1 &

7KH)7 PRGXOXV GDWIDYBURWQRHGW IDLQFIQWMMK/M HETXFLDYDCHV
VDPSOH PHDQ YDQERYH WKHVXSSHU DFFHSWVEEFH OLPLW
HTXLYDOHQF\ VDPSOH PHDQ RYDOKH XSSHUHSWDEWHR YDOXH V

0DUFK

1&3 53

5HY 1 &

)LJXUH LOOXVWUJWDIR @WKUH@KRWK PPIYD@D@G IRLQWKH
TXDOLILFDWDRG WDPHS@FXLYDOHQF\ VDF@YD@K@FO LPLASOH
DUH VKRZQ DV HUWRH EXD@G@W@W@K HD@K@V@HU FRORUHG HU
DUH IRU WKH PRGLILHG &9 FRPSXWDWLRQV



,Q 30DQH 6KH DU ,36

7KH ,Q 30DQH 6KH DRU B D O D I H G Q R W O B S D V U H Q G V D O G D W
 HTXLYDOHQF\ WHVWXV G D W D B S P R G H G H T X R V D O K H Q & 7 W H V W
 FRQGLWLRQ EXW Q R R Q W K K H 5 7 H Z R Q G L R V 6 W W D H L Q Q V G D W D D Y D L O
 IRU WKH 0 FXUH F \ F B G L Q W R K Q 8 7 R G L Z H H G Q R W H S / U P Y L G H G I
 2 I I V H W & 7 ' G D W D V H W E R F D I L V H H Q W B E R Y D H L D W K R K Z D
 PHDQV W K D W W K H P R Z H U H Q R & G U H N X H O X V W U R P K R Z Q U 7 K H U
 Z H U H L Q V X I I L F L H Q M H V , S 6 F L P H Q W H Q W D W H H Q J R V K G D W & 7 '
 FRQGLWLRQ IRU V F R Q V L H G V K O H G V F R R F E H X D Q G H D Q D O D W I L W W H V X O
 V K R Z Q IRU W K H K I D O H G V 6 W W U H Q J W K V W L Q 6 7 D E D L Q G D D Q
 IRU W K H 0 R G X O X V D E D W

,Q 30DQH 6KH DU ,36	2 I I V H W		6 W U D L Q	
	6 W U H Q J W K	5 7 '	5 7 '	4 X D O (T X L Y
'DWD DV PHDVXUHG ,QVXIILFLHQW 'DWD 0HDQ 6WUHQJWK NVL 6WDQGDUG 'HYLDWLRQ &RHIIILFLHQW RI 9DULDWLRQ 0LQLPXP 0D[LFP 1XPEHU RI 6SHFLPHQV				
5(68/76	3\$66	3\$66	3\$66	
0LQLPXP \$FFHSWDEOH (TXLY 6DPSOH 0HDQ				
0LQLPXP \$FFHSWDEOH (TXLY 6DPSOH 0LQ				
02' & 9 5(68/76		3\$66 ZLWK 02'	3\$66 ZLWK 02'	& 9
0RGLILHG & 9 1\$				
0LQLPXP \$FFHSWDEOH (TXLY 6DPSOH 0HDQ				
0LQLPXP \$FFHSWDEOH (TXLY 6DPSOH 0LQ				

7 D E O H , Q K 3 O D Q H 6 W U H Q J W K 5 H V X O W V

,Q 30DQH 6KH DU ,36	6 W U H Q J W K		5 7 '	
	4 X D O	(T X L Y	D	O
'DWD DV PHDVXUHG ,QVXIILFLHQW 'DWD 0HDQ 6WUHQJWK NVL 6WDQGDUG 'HYLDWLRQ &RHIIILFLHQW RI 9DULDWLRQ 0LQLPXP 0D[LFP 1XPEHU RI 6SHFLPHQV				
5(68/76	3\$66			
3DVVLQJ 5DQJH IRU 0RGXOXV 0HDQ			WR	
6WXGHQW V W V W D W L V W L F				
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02' & 9 5(68/76	3\$66 ZLWK 02'	& 9		
0RGLILHG & 9				
3DVVLQJ 5DQJH IRU 0RGXOXV 0HDQ			WR	
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S Y D O X H R I 6 W X G H Q W V W V W D W L V W L F				

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HTXLYDOHQF\ VDP SDVH PHDQ RYD W KH X S S F U H S W D E V H R Y D O X H V
8QGHU WKH DVVX P S O L L R Q G R & W R H W P K R G W K F S O R X P L Y D O H L Q F \
RI WKH PD [L P X P D F F H S W D E O H P H D Q Y D O X H
) L J X U H L O O X V W D Q W H K H W K U H V , W U S Q Q W R X P H Y D O X D H Q G D R I G W
P R G X O X V P H D Q V I R U W K H T X D O L I L F D W L

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3 ' 2SHQ +ROH &RPSUHVVLRQ 2+&

7KH 2SHQ +ROH &RPSUHVVLRQ 2+& \LQXUHG \$ON W&SHQ+RO
 &RPSUHVVLRQ QRUP DOW DOW DOW DOW DOW DOW DOW DOW DOW DOW DOW
 (7: FRQGLWLRQV DOW DOW DOW DOW DOW DOW DOW DOW DOW DOW DOW
 PHWKRG WR SDVV IWKFLHQV DOW DOW DOW DOW DOW DOW DOW DOW DOW
 FRQVLGHUH FRQFOXVLYH DOW DOW DOW DOW DOW DOW DOW DOW DOW DOW
 VKRZQ LQ 7DEOH

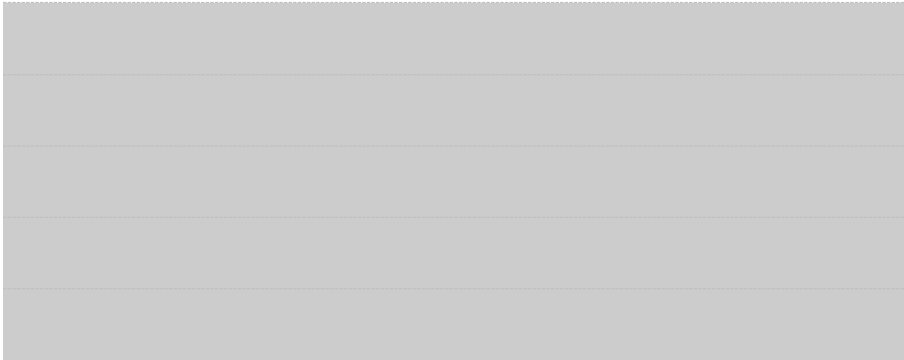
2SHQ +ROH &RPSUHVVLRQ 2+&	(7:
6WUHQJWK 4XDO (TXLY	4XDO (TXLY
'DWD QRUPDOLJHG ZLWK &37	,QVXIIIFLHQW 'DWD
0HDQ 6WUHQJWK NVL	
6WDQGDUG 'HYLDWLRQ	
&RHIIIFLHQW RI 9DULDWLRQ	
0LQLPXP	
0D[LFXP	
1XPEHU RI 6SHFLPHQV	
5(68/76	3\$66
0LQLPXP \$FFHSWDEOH (TXLY 6DPSOH 0HDQ	
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02' &9 5(68/76	3\$66 ZLWK 02' &9 3\$66 ZLWK 02' &9
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)LJXUH LOOXVWURDWH & RVPISH HZSVILQR QVVWVUGH QJLQKPPHPD Q
YDOXHV IRU WKH TXDODQLG DWKLR BTXD PFKOHQEP LMDVSBH
HTXLYDOHQF\ VDP SOHMURB H EBZQZ DWKQWGB WTXDOKHLERWJH
OLJKWHU FRORUHGU HWKLR BREGLU VHDGU & 9I R R P S X W D W L R Q V



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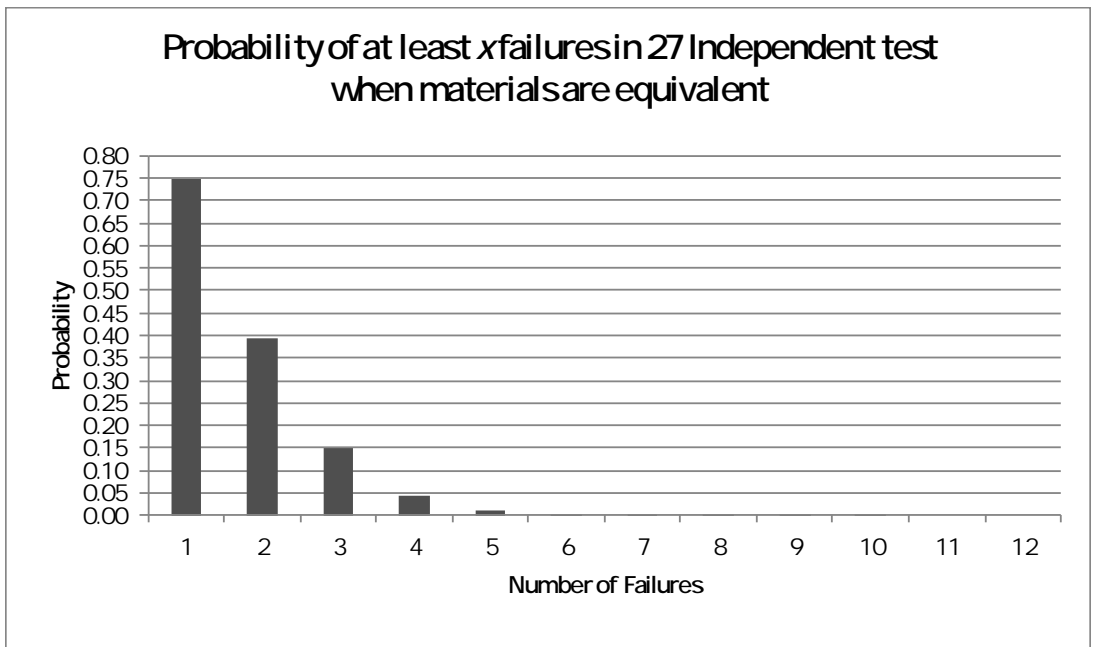
&XUHG 30\ 7KLFNQHV V &37

7KH &XUHG 30\ 7KLFNQHV V G HFDQGEHT XL YD R HQWH DFFVRUOGLVQ R I
SRROHG WZR VDP SOHVOR D EODI VLGRQI WGM EWH VOHLYHVOIRU ER
RULJLQDO 0+ FXUHLRQ E OHD FSO D LD QGD W KHT & LFYDCH Q FFOV D P S O
DUH VKRZQ LQ 7DEOH

&XUHG 30\ 7KLFNQHV V &37 4XDO (TXLY
\$YHUDJH &XUHG 30\ 7KLFNQHV V
6WDQGDUG 'HYLDWLRQ
&RHIILFLHQW RI 9DULDWLRQ
0LQLPXP
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1XPEHU RI 6SHFLPHQV

3UREDELOLW\ RI)DLOXUHV

,I WKH HTXLYDOHQFRV DPBDWFUDLPHOIZWWRKVFKGDHUVWVWHDUWWR
 RULJLQDO TXDODQLDQGLRQOPDMMWVLRZHDHDLQVGHVQWV
 FKDQFH RI KDRULQRQHQLDLOXUHVVXUVH LOOXVWUDWVWKH
 RI JHWLQJ RQH RWZRRUHU IDROXUDDOXHVVRIHWEQGRHSHQGH
 WHVWV ,I WKH WZRHPTXLYDODHUVZHWKMSUREDELOLWDLQXUH
 LV OHVV WKDQ 7KWK/HPHDQNUWDDWFR&ODG/ERFRVQVTLXGHDH
 ZLWK D OHYHO RI WFRPHGZHQFHIBXUVRURXVCRHSHQGHQW
 WHVWV



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