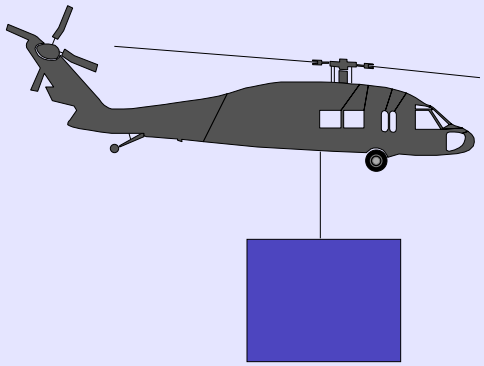
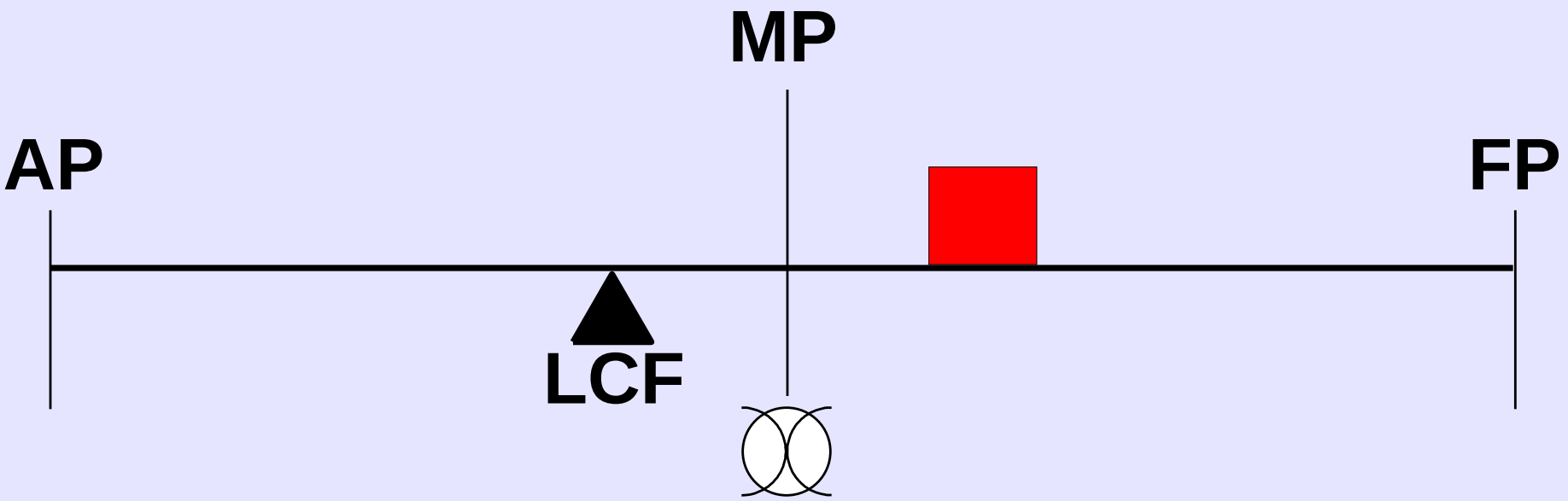


Lesson 4.4

Trim and Draft



References

- NSTM 079 Volume 1
- NTTP 3-20.31
- Damage Control Book, section II (a)

Enabling Objectives Covered:

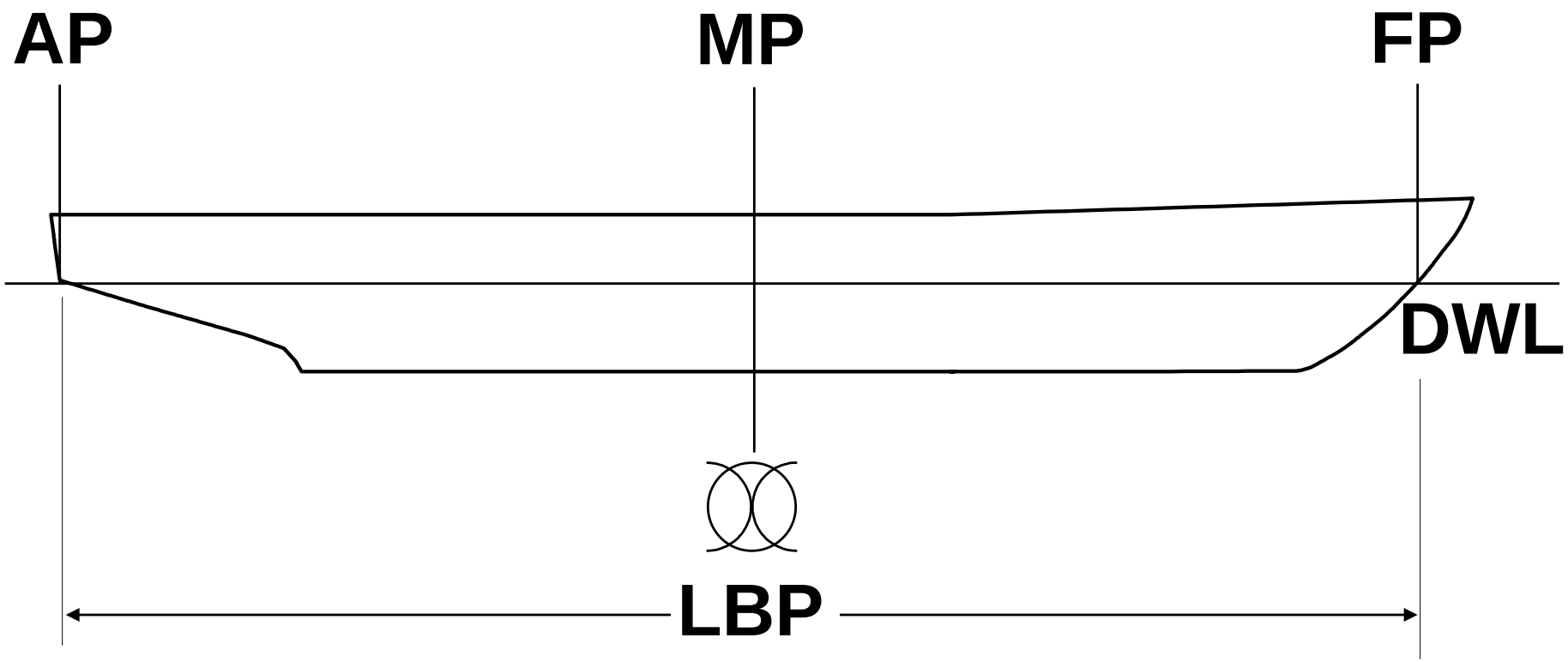
- EXPLAIN why trim and loading affect intact stability.
- DEFINE drag, trim, trimming moment, PR/PS, plunging, and LCF.
- COMPUTE impact of longitudinal weight shifts, additions, and removals on ship’s trim and drafts.

Enabling Objectives Covered:

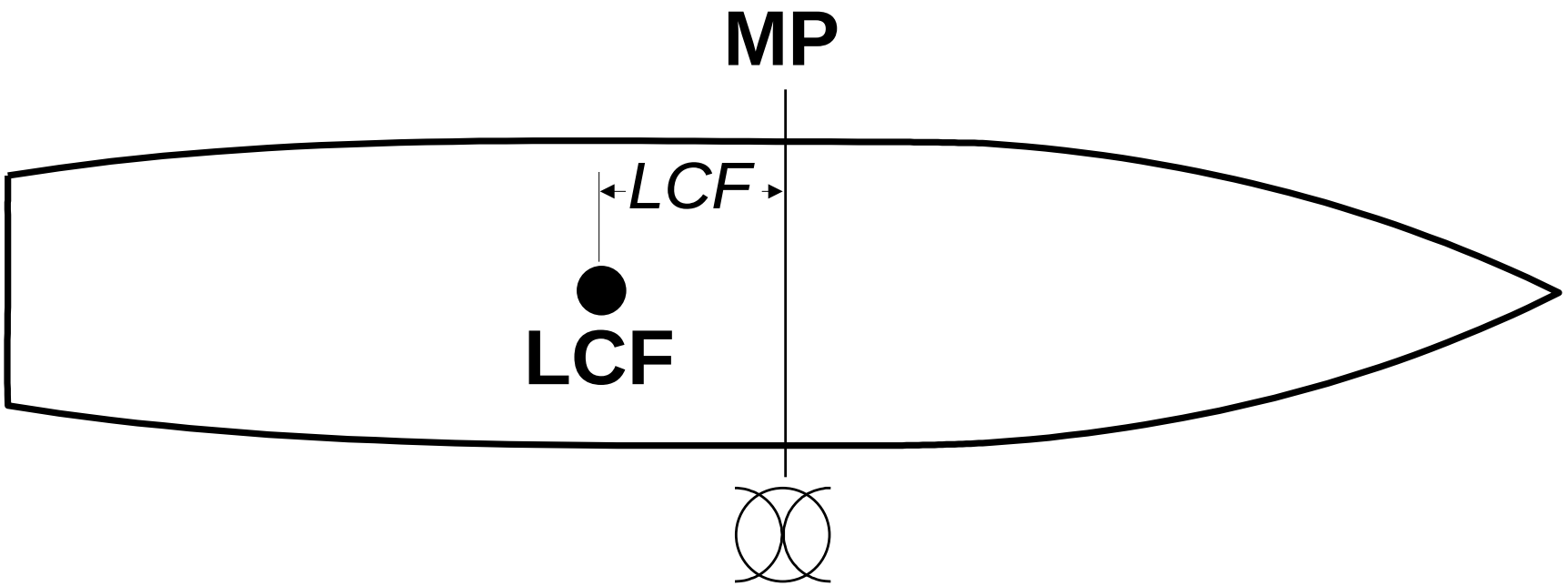
- CALCULATE how to correct trim.
- COMPUTE final trim and drafts after damage.
- DESCRIBE movement of reference points caused by weight shifts, additions and removals. **(You should know this one already for transverse direction!!)**

Class Timeline…

- Longitudinal Stability Terms
- Drag / Trim
- Longitudinal Weight Shifts
- Longitudinal Weight Adds/Removals
- Examples

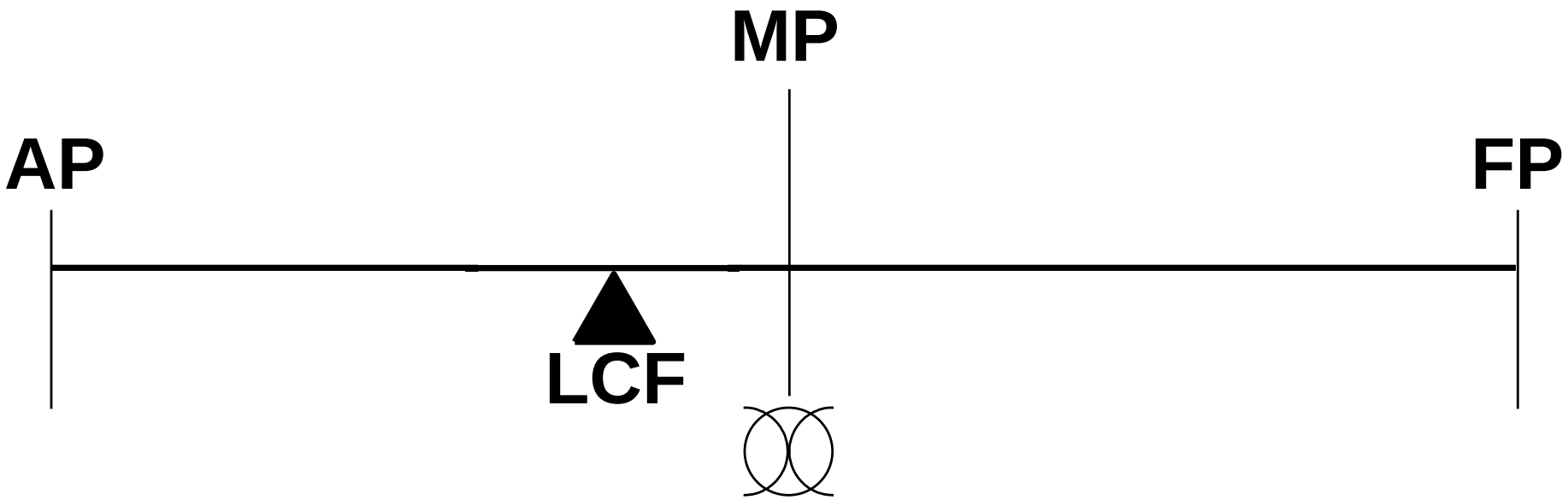

AP
MP
FP
DWL
LBP

"Bird's Eye View"

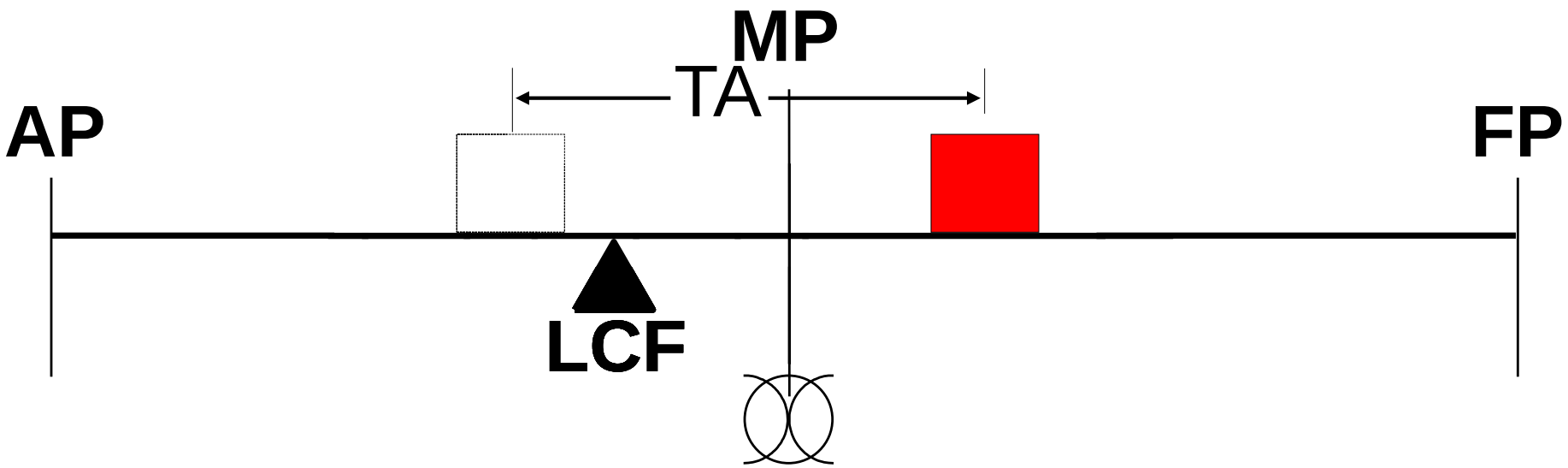


LCF - The Longitudinal Center of Flotation

"Side View"



Trimming Moment = w x TA

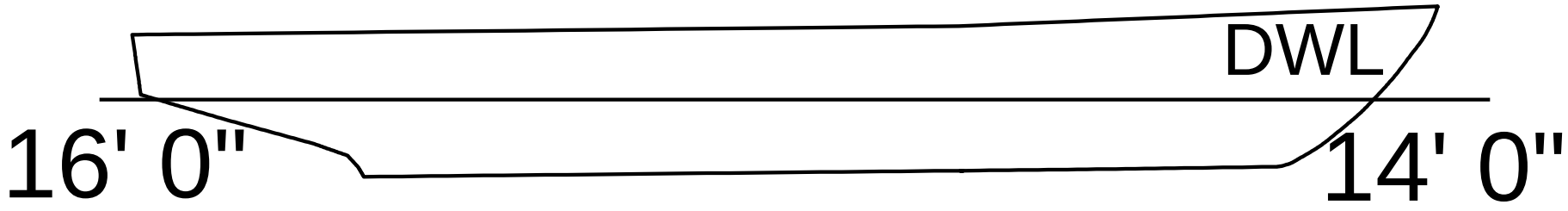


SHIFT - TA equals the longitudinal distance shifted

Class Topics

- ~~Longitudinal Stability Terms~~
- Drag / Trim
- Longitudinal Weight Shifts
- Longitudinal Weight Adds/Removals
- Examples

DRAG - A design feature having draft aft greater than draft fwd. *Primarily done to increase plant effectiveness.*

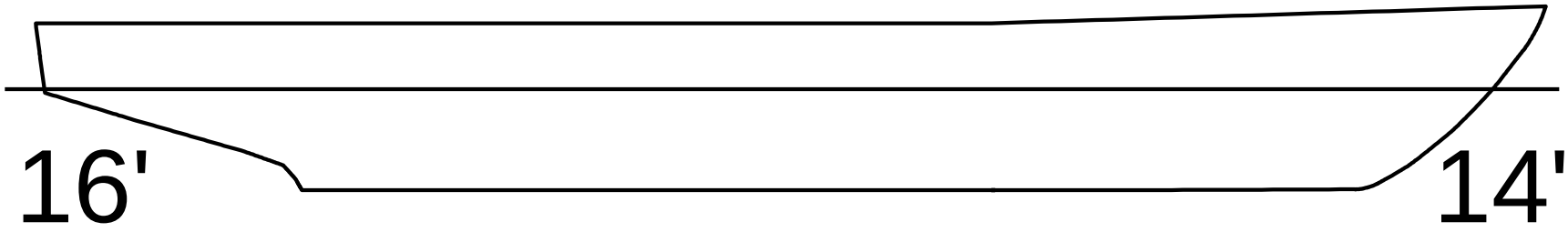


DRAG = 2 FT By the Stern

Example of Ship Cross Section

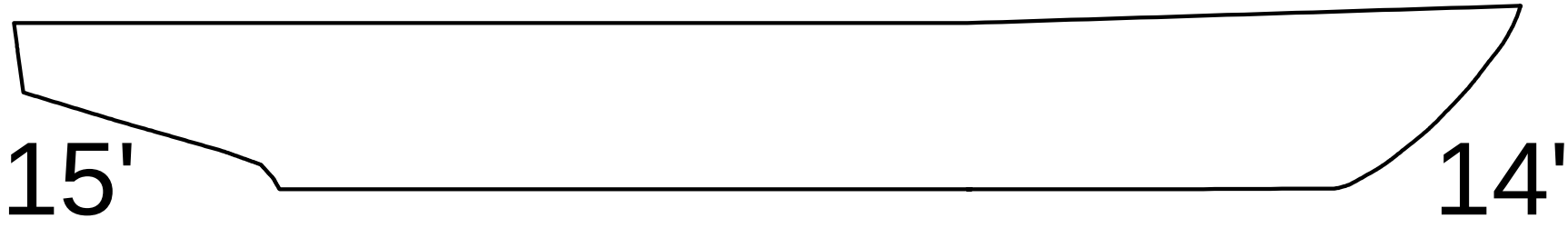
TRIM - The difference between the fwd and aft drafts in excess of drag.

DRAG = 0



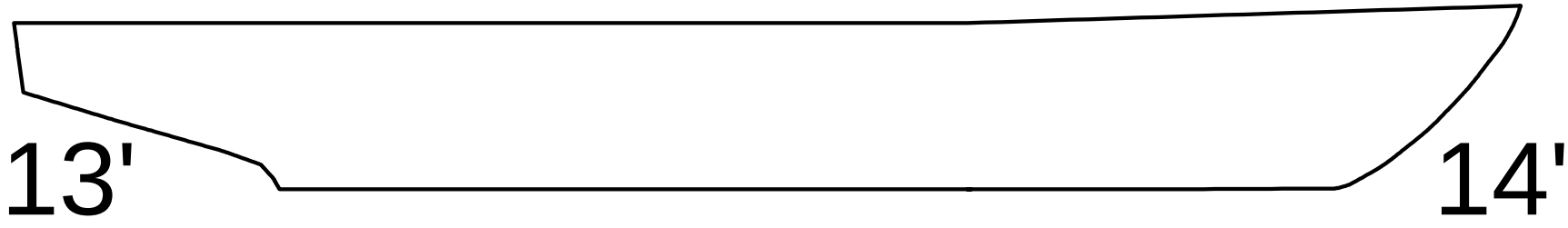
TRIM = 2 FT By the Stern

DRAG = 1 Ft By the Stern



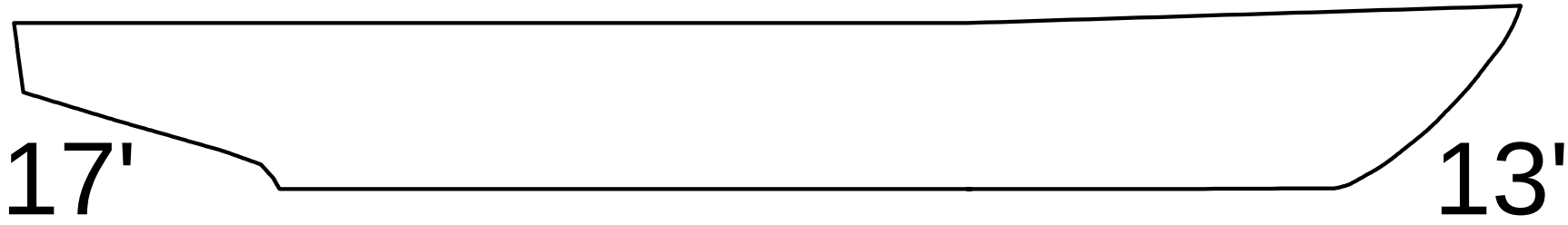
TRIM = 0

DRAG = 1 Ft By the Stern



TRIM = 2' By the Bow

DRAG = 1 Ft By the Stern

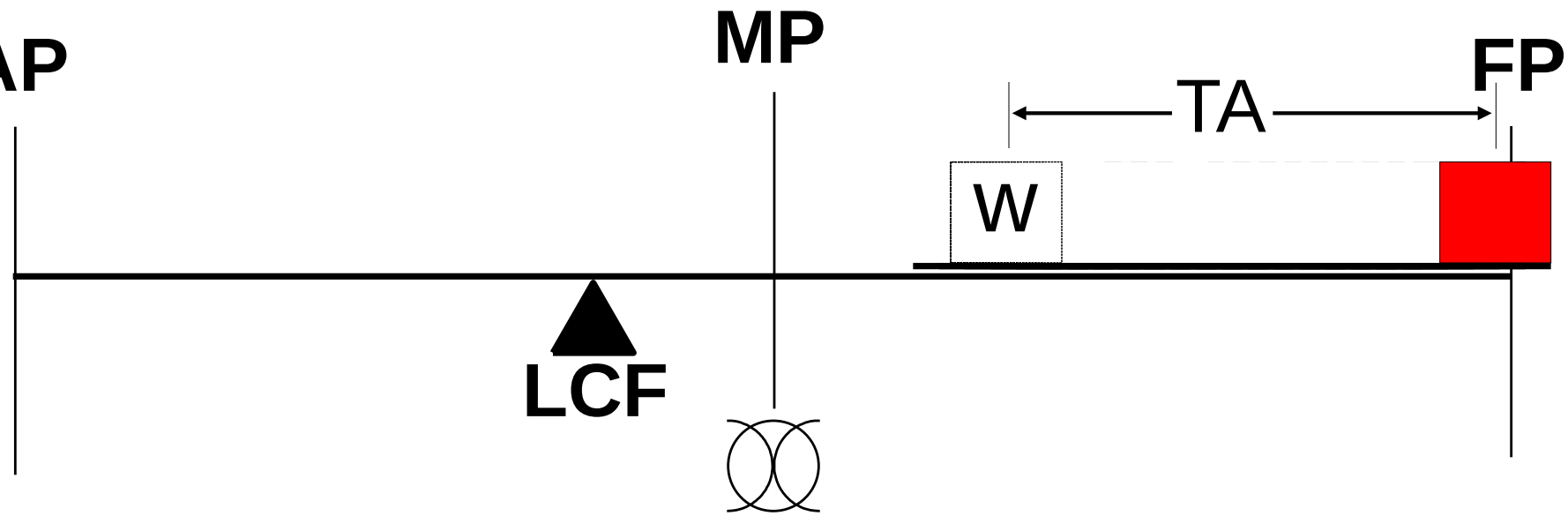


TRIM = 3' By the Stern

Class Topics

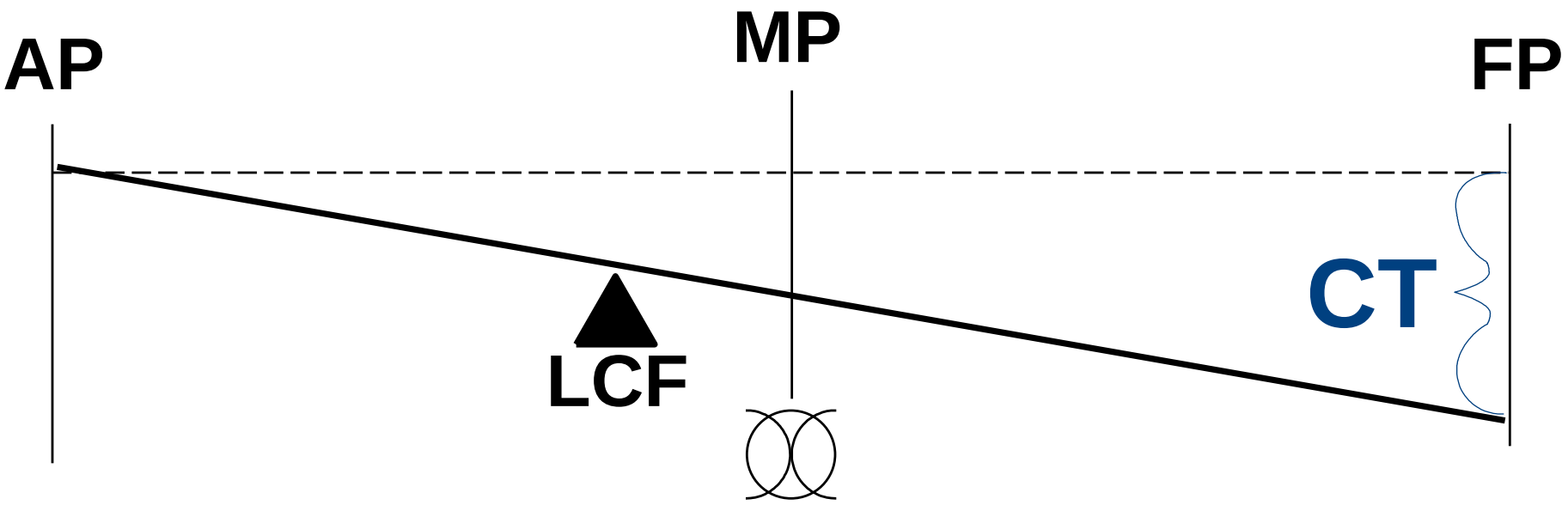
- ~~Longitudinal Stability Terms~~
- ~~Drag / Trim~~
- Longitudinal Weight Shifts
- Longitudinal Weight Adds/Removals
- Examples

Trimming Moment = TA x w

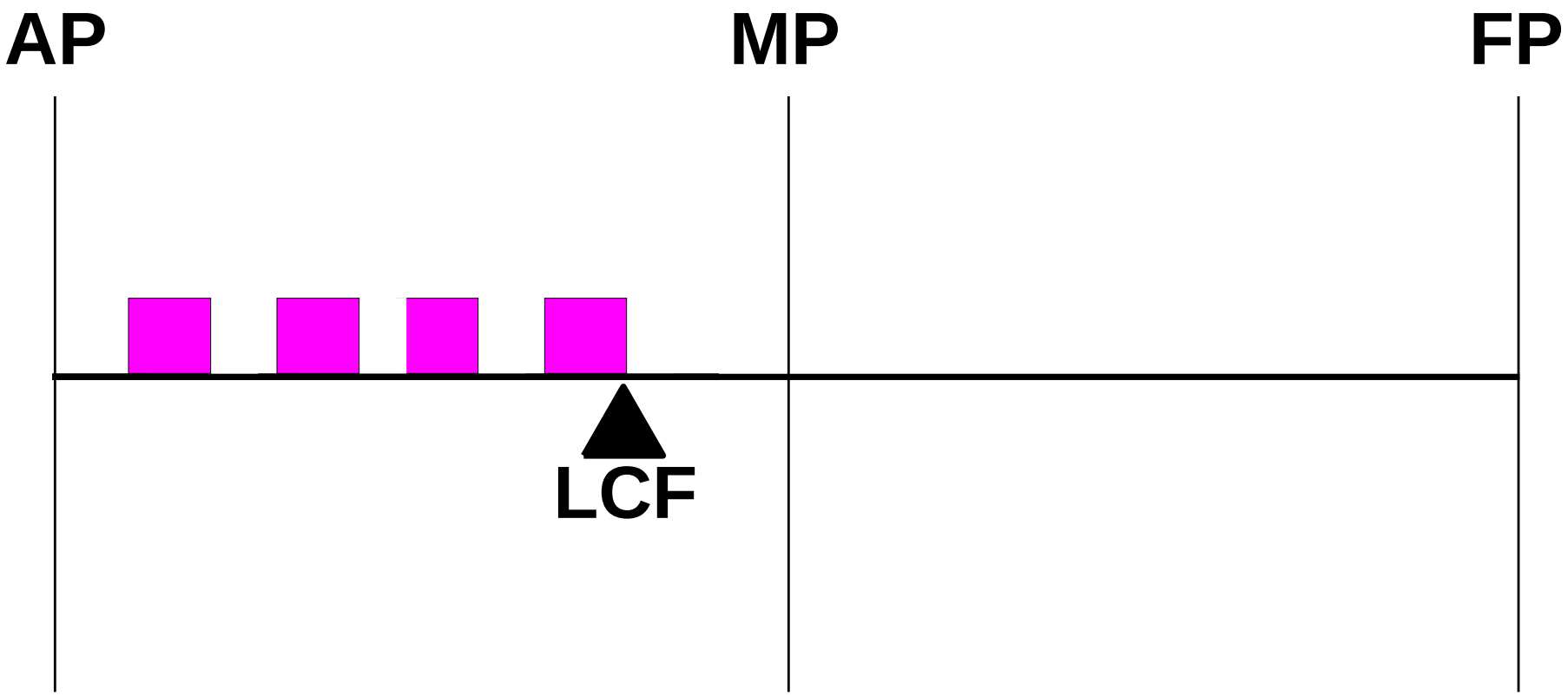


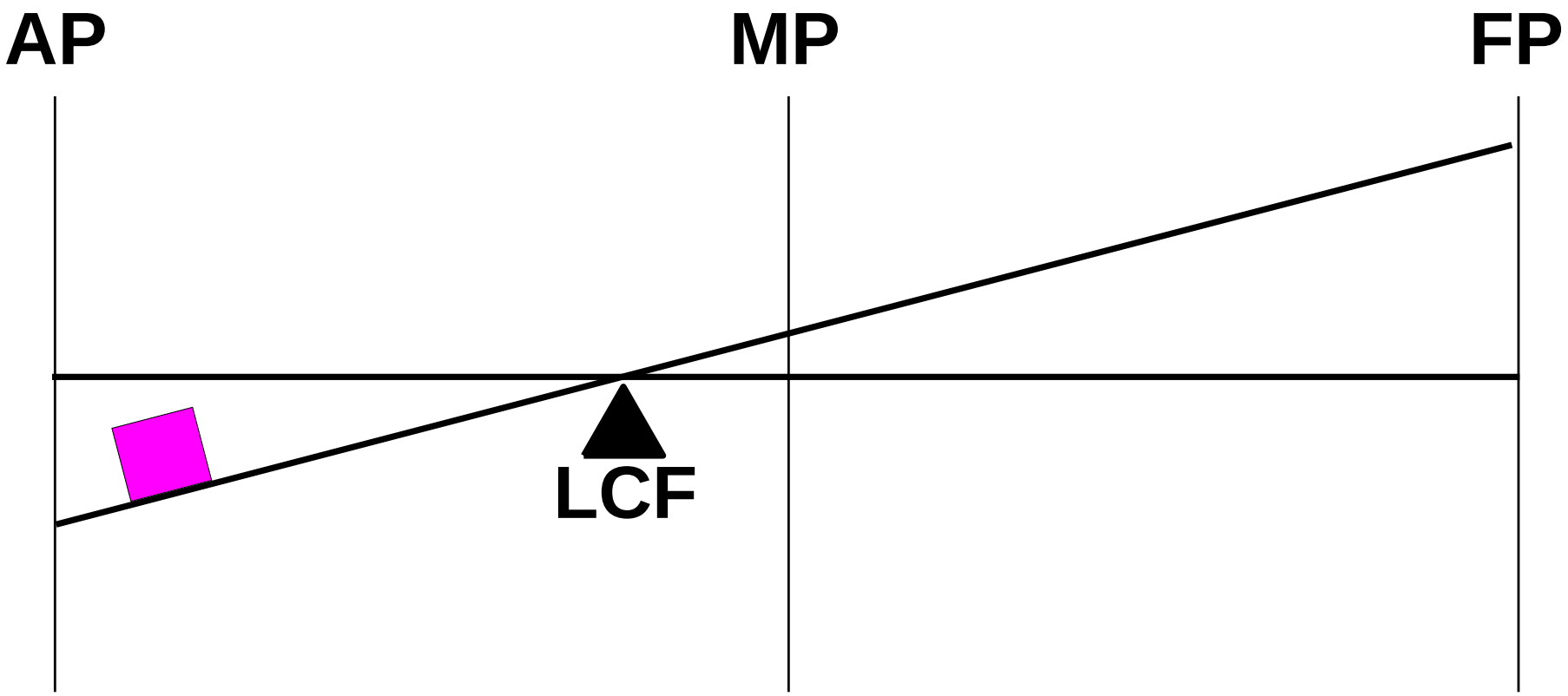
Change in Trim (CT) = $\frac{TM}{MT1"}$

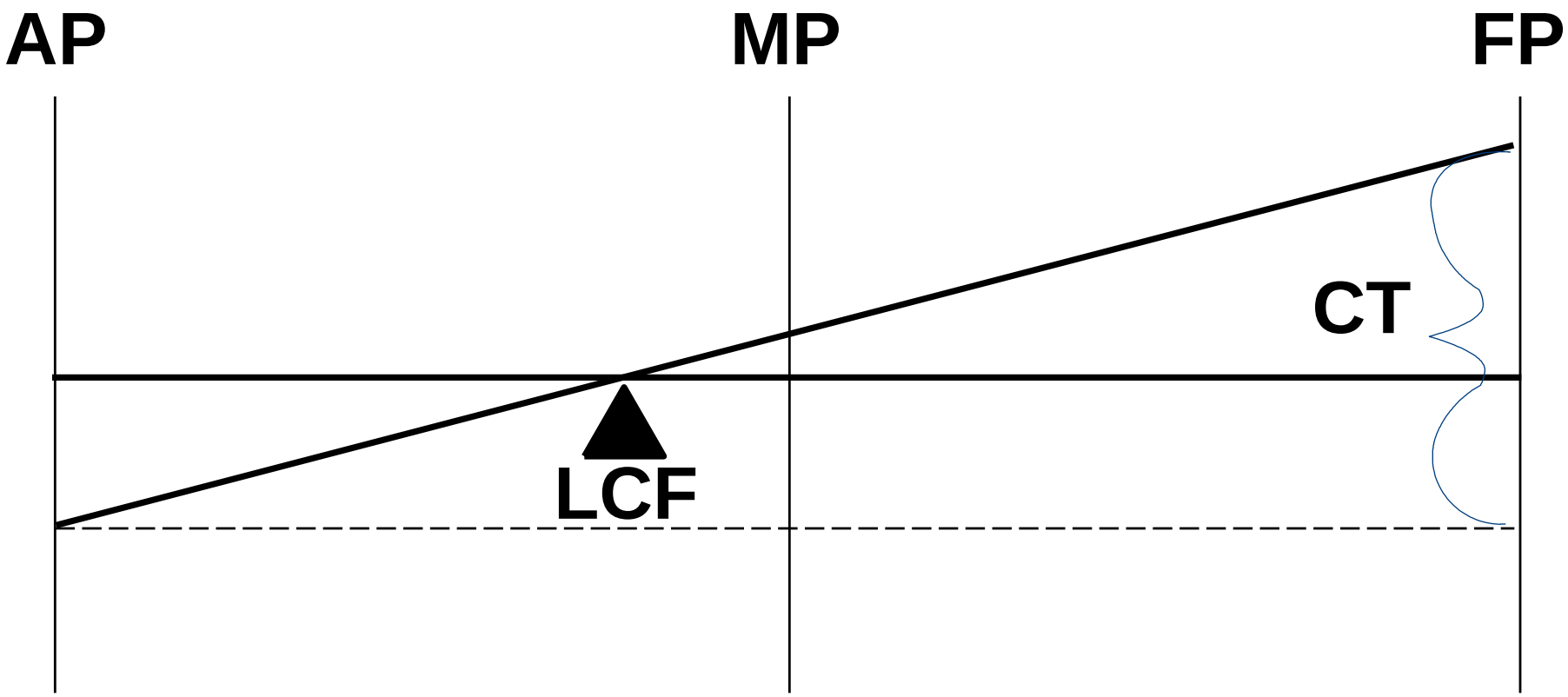
Trimming Moment = w x TA

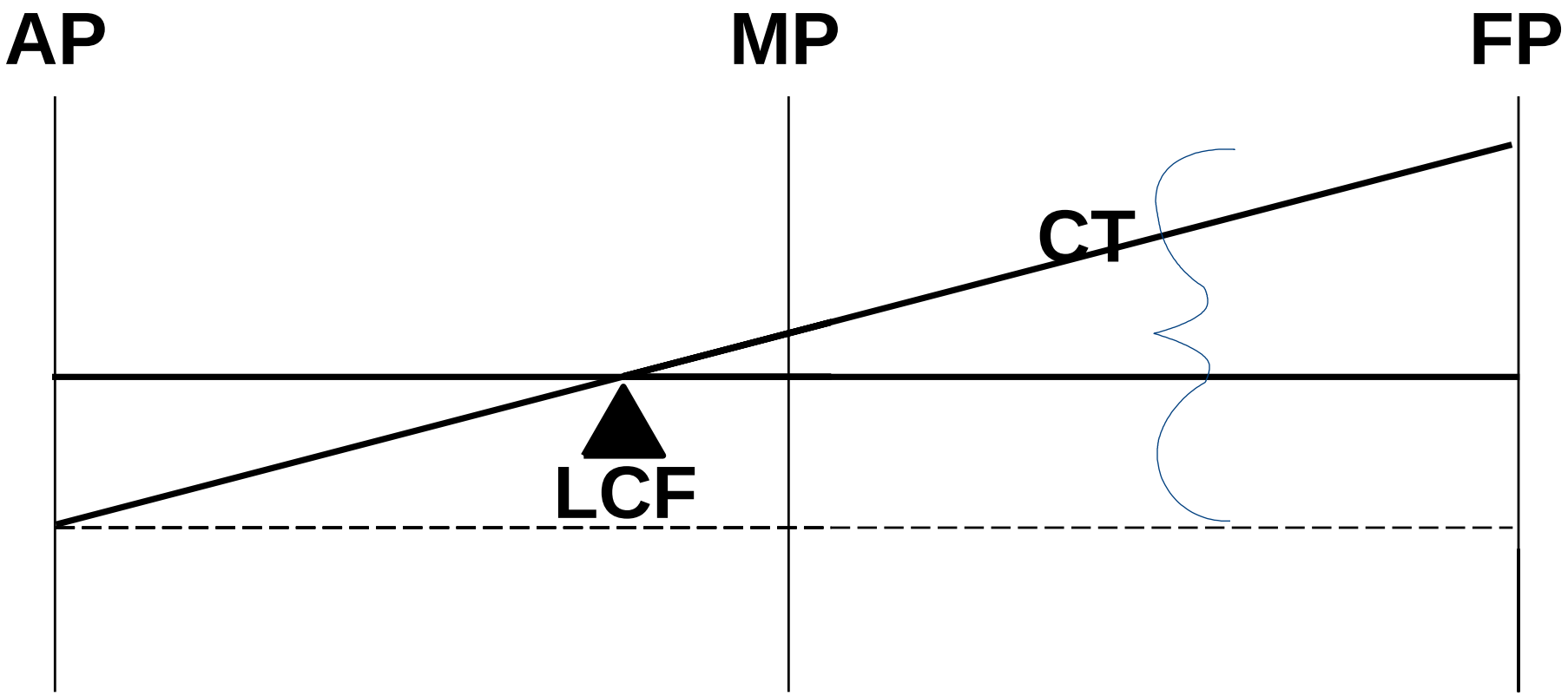


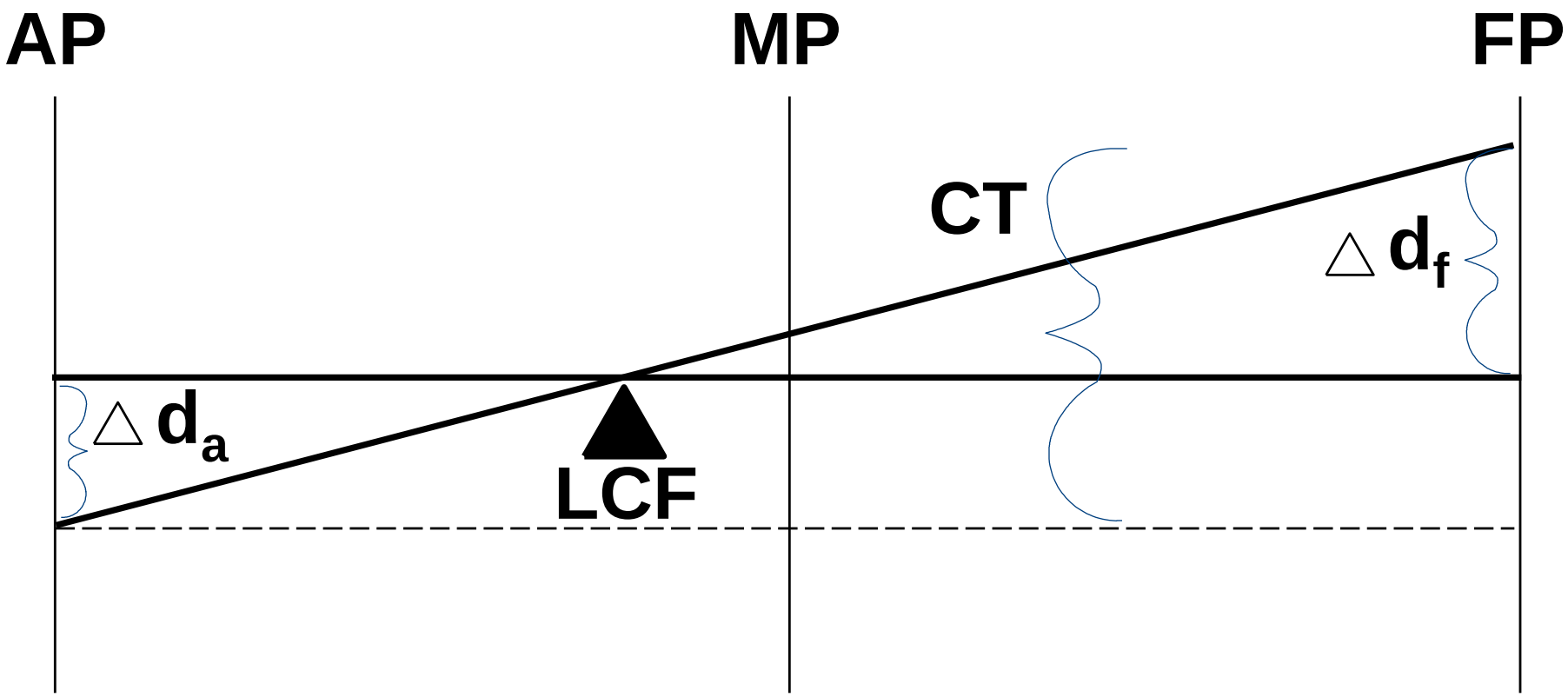
$$\text{Change in Trim(CT)} = \frac{\text{TM}}{\text{MT1"}}$$


AP
MP
FP
LCF

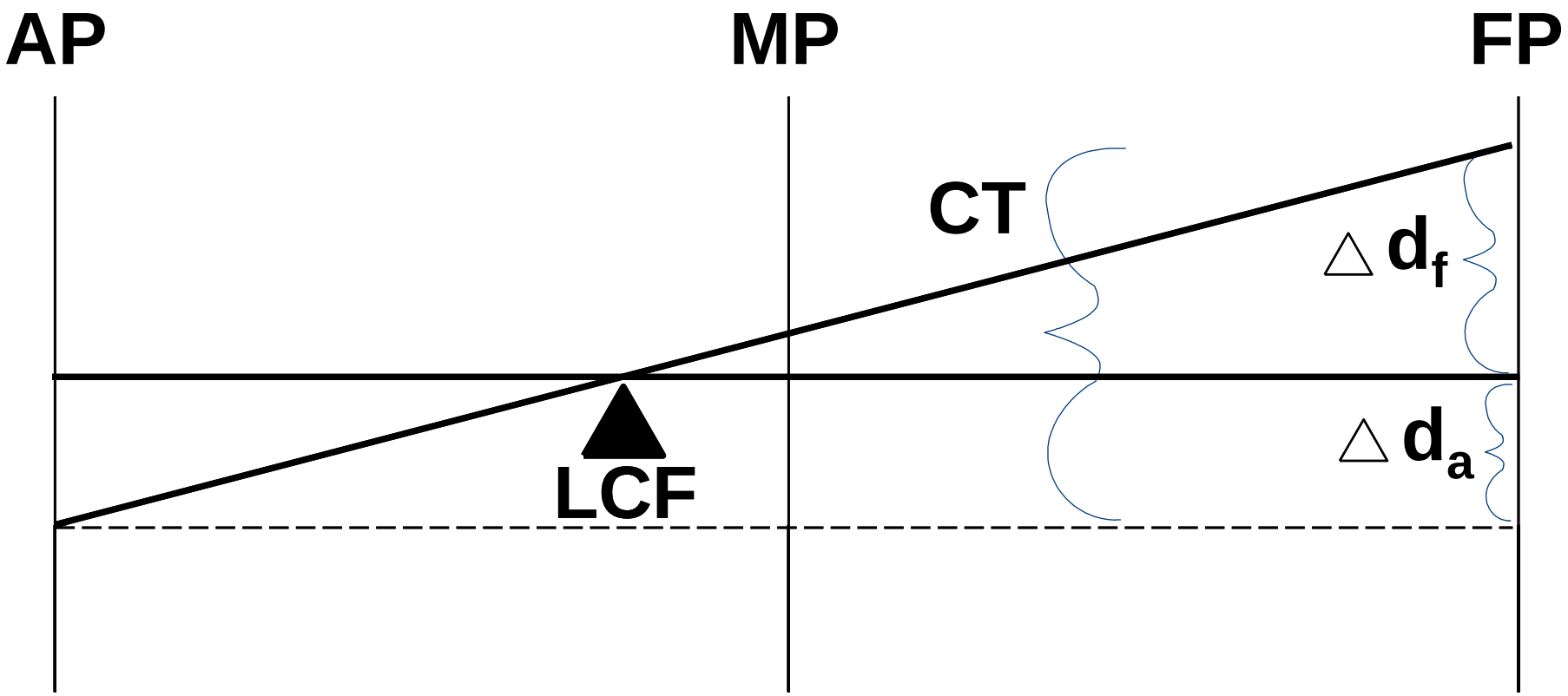

AP
MP
FP
LCF


AP
MP
FP
CT
LCF

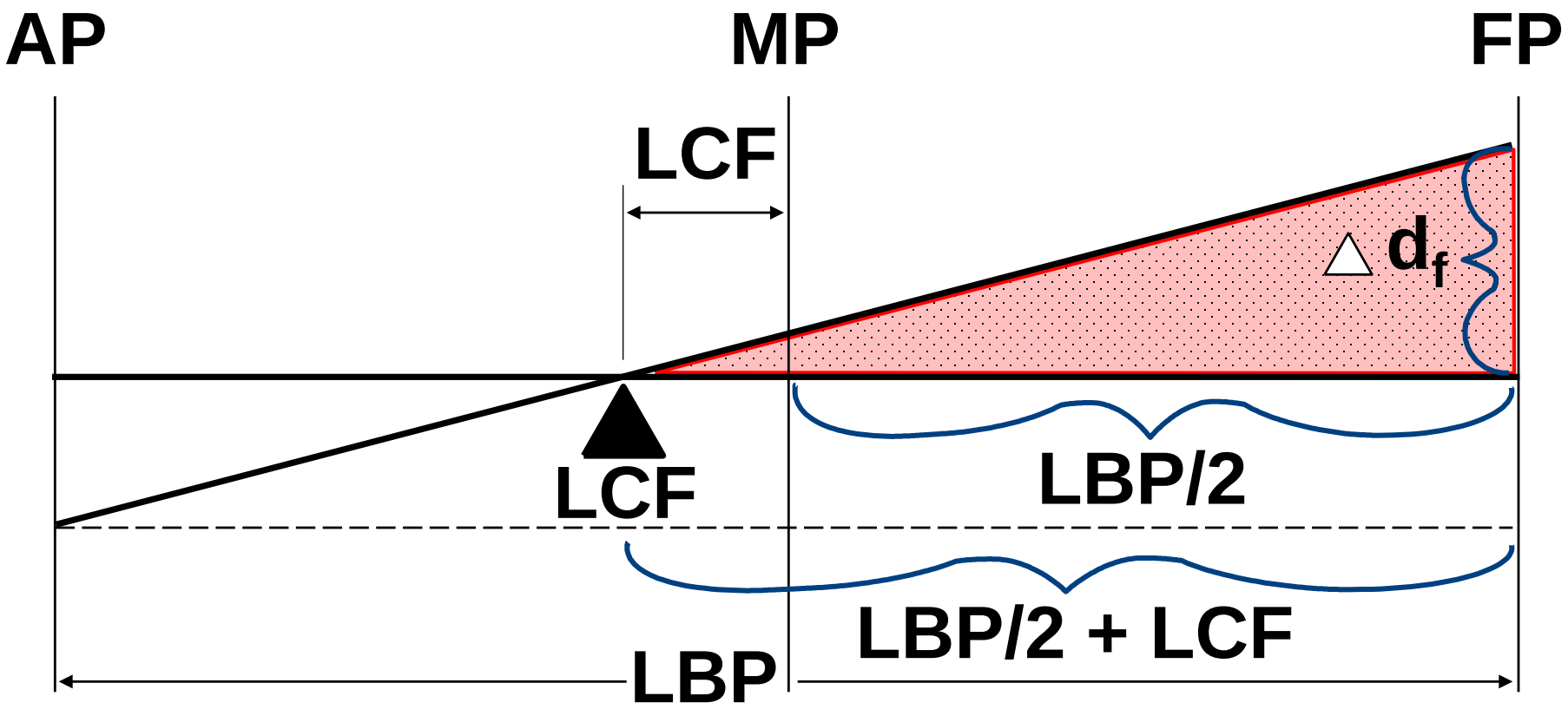

AP
MP
FP
CT
LCF

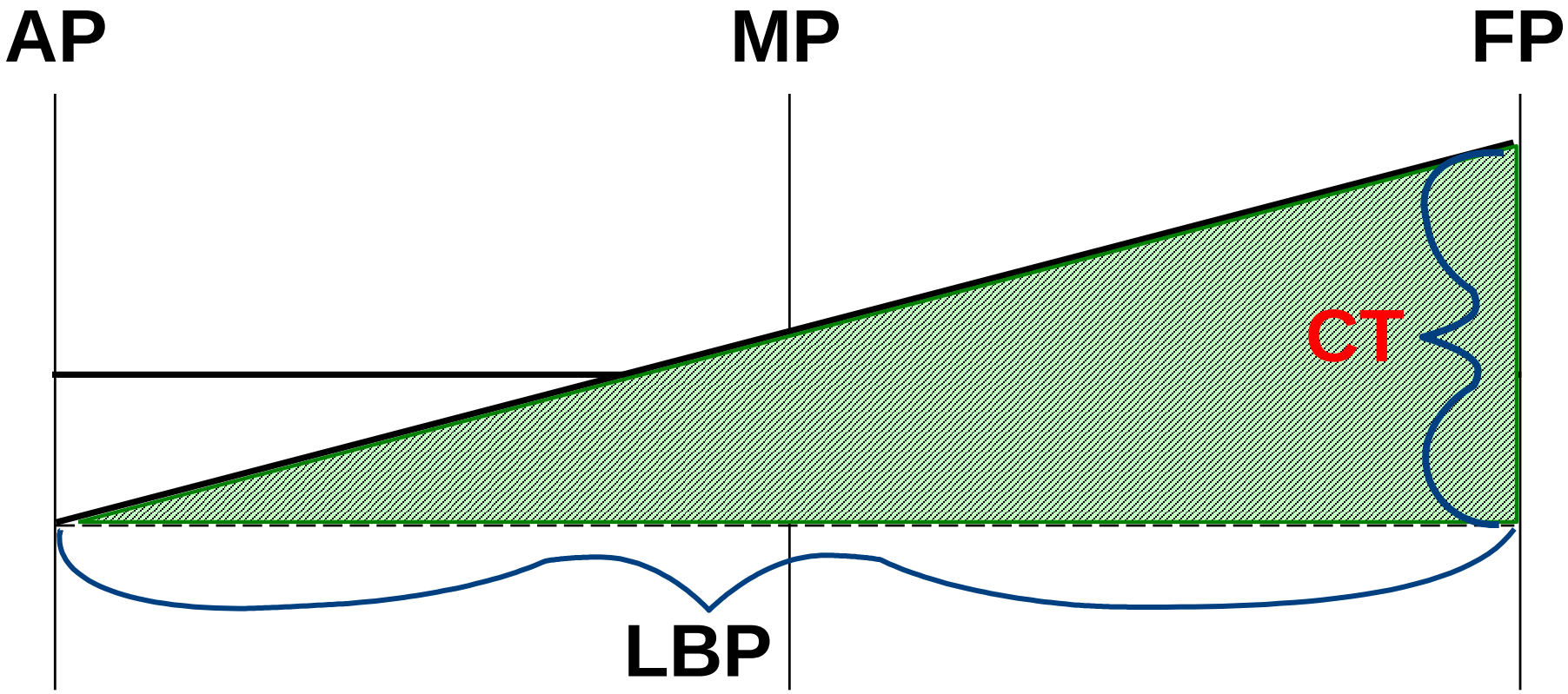

AP
MP
FP
CT
△ d_f
△ d_a
LCF

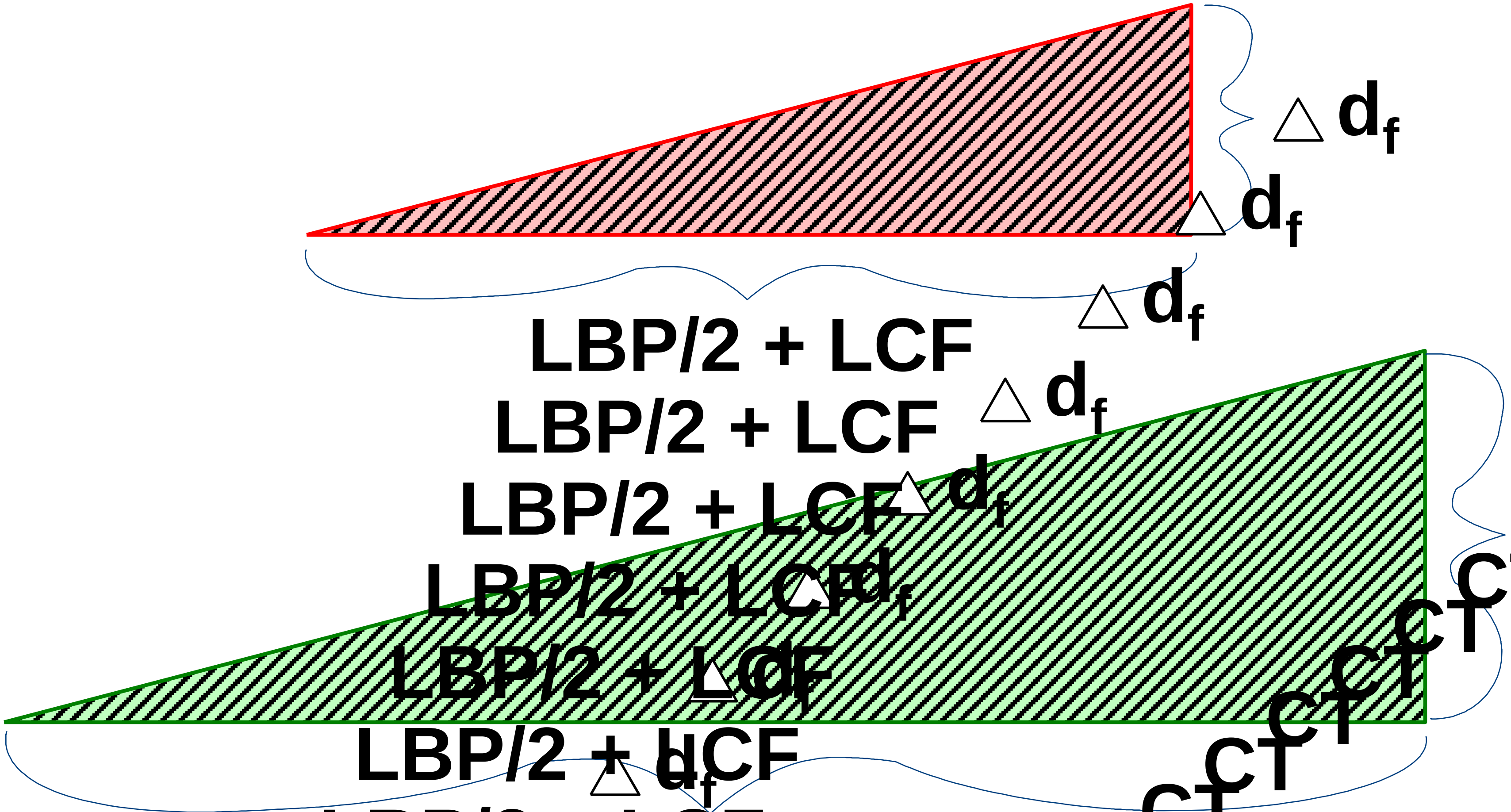
$$CT = \triangle d_f + \triangle d_a$$



$$CT = \triangle d_f + \triangle d_a$$




AP
MP
FP
CT
LBP



$$\frac{\triangle d_f}{LBP/2 + LCF} = \frac{CT}{LBP}$$

$$\frac{\triangle d_f}{LBP/2 + LCF} = \frac{CT}{LBP}$$

$$\triangle d_f = \frac{(LBP/2 + LCF)}{LBP} \times CT$$

$$CT = \triangle d_f + \triangle d_a$$

$$\triangle d_a = CT - \triangle d_f$$

Class Topics

- ~~Longitudinal Stability Terms~~
- ~~Drag / Trim~~
- ~~Longitudinal Weight Shifts~~
- Longitudinal Weight Adds/Removals
- Examples

Class Topics

- ~~Longitudinal Stability Terms~~
- ~~Drag / Trim~~
- ~~Longitudinal Weight Shifts~~
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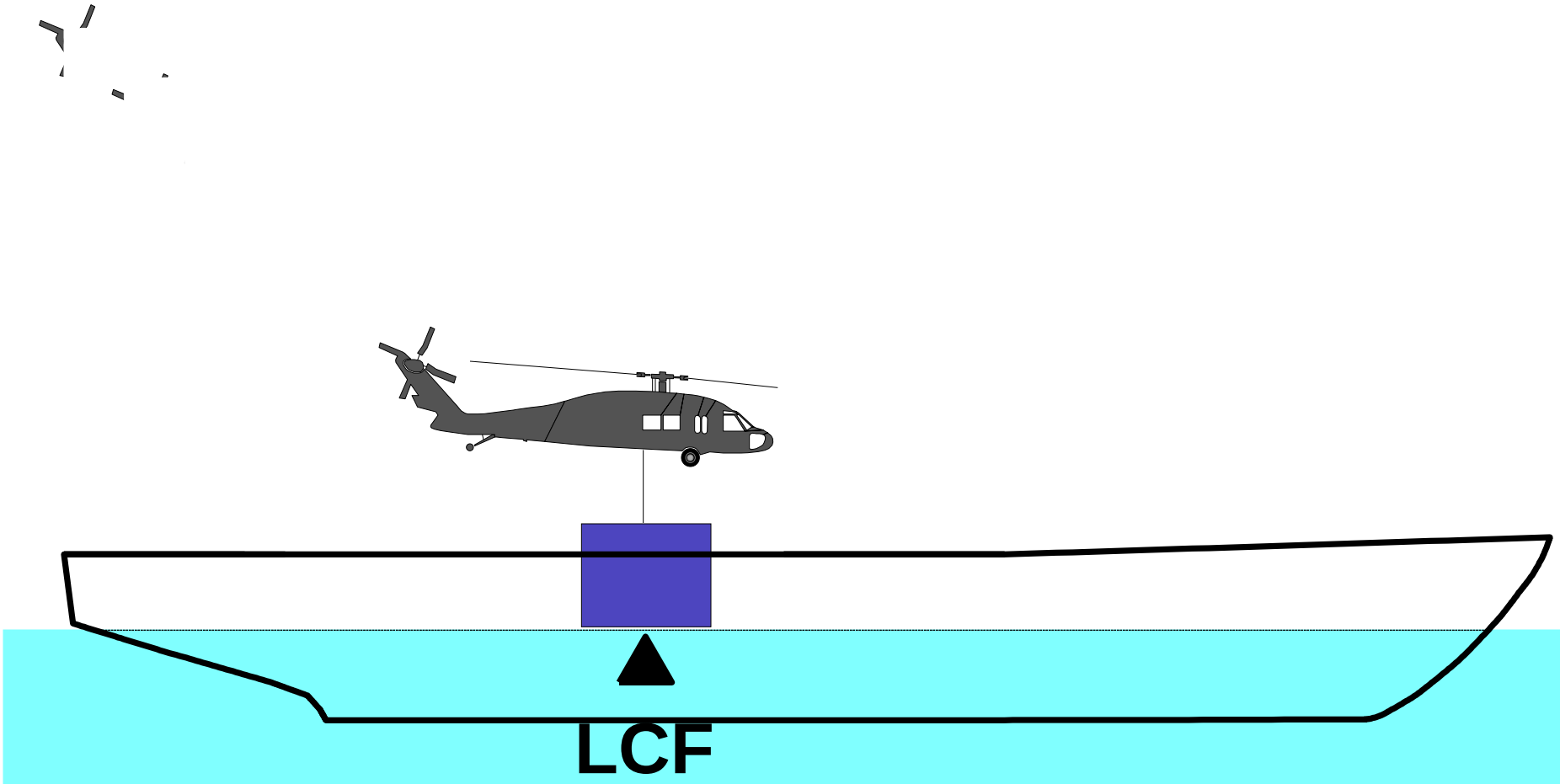
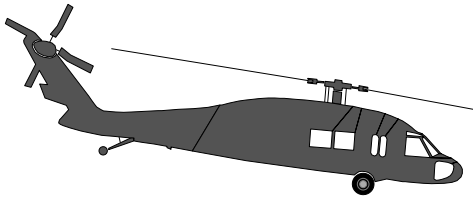
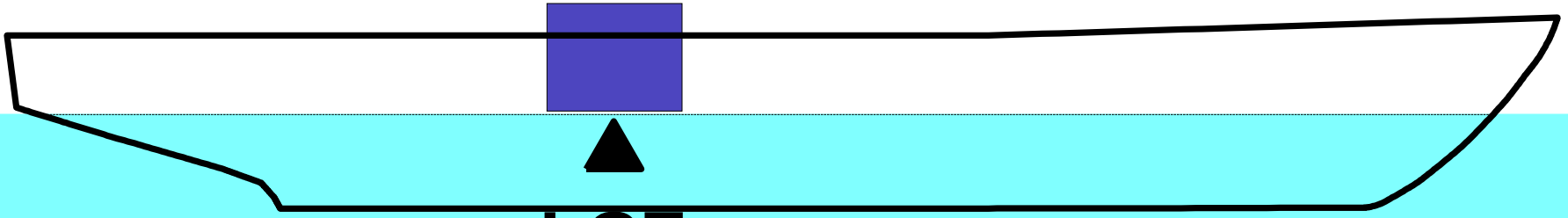
- Examples


LCF

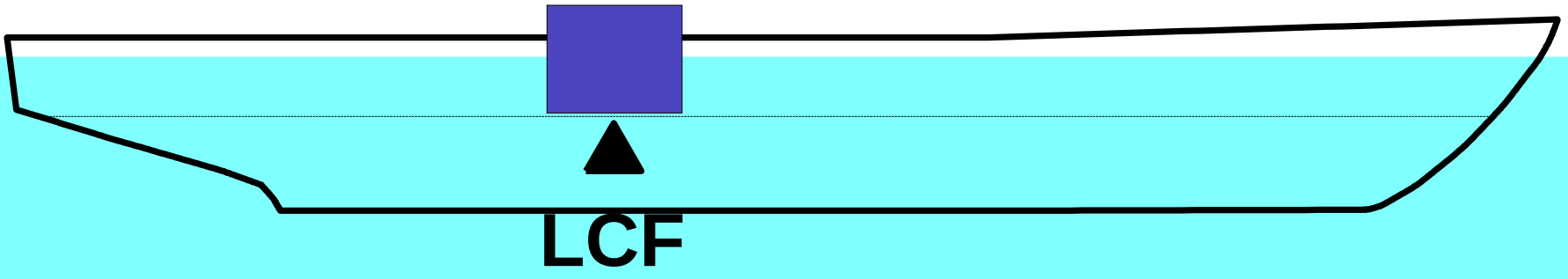




LCF

PARALLEL SINKAGE = $\frac{w}{TPI}$

Parallel Sinkage (PS) is the distance that the drafts fore and aft increase due to a weight addition.



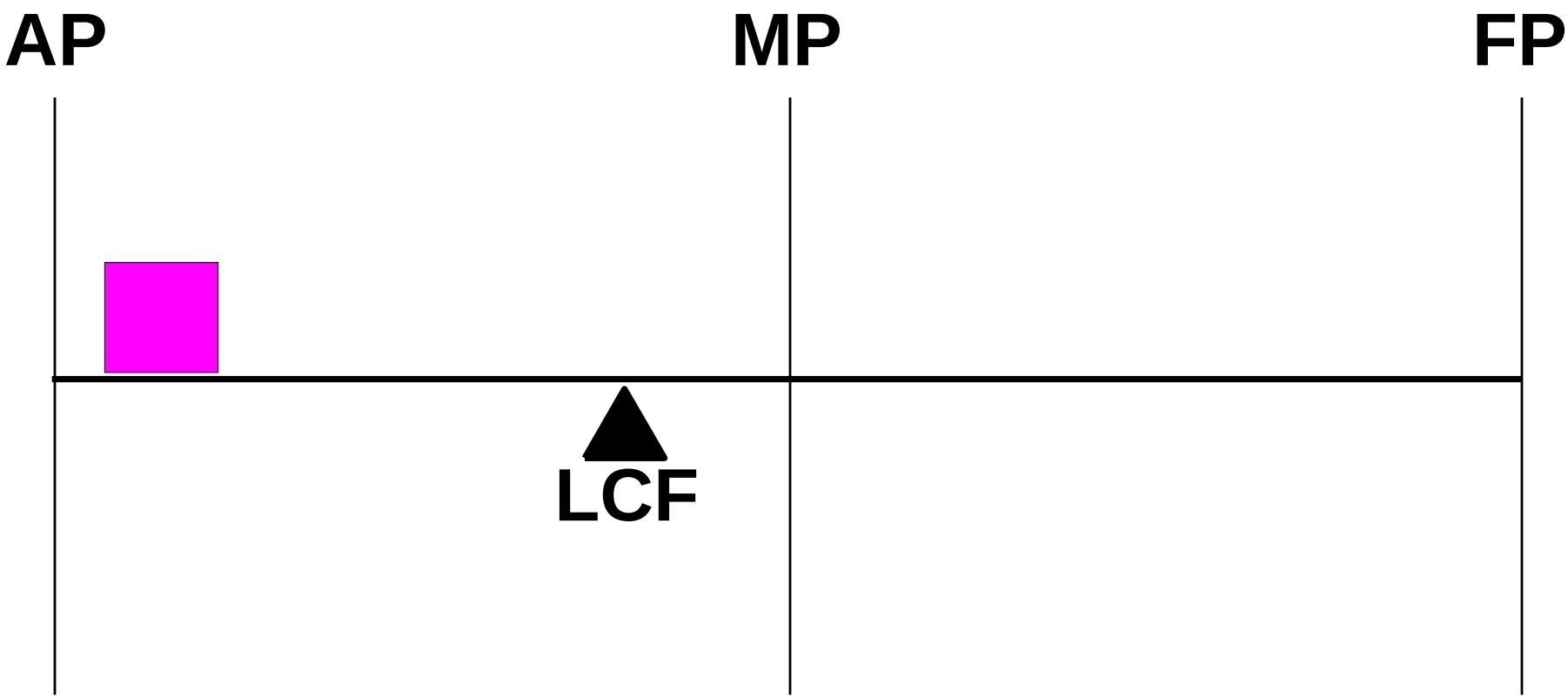
PARALLEL SINKAGE = $\frac{w}{TPI}$

Parallel Sinkage (PS) is the distance that the drafts fore and aft **increase** due to a weight addition.

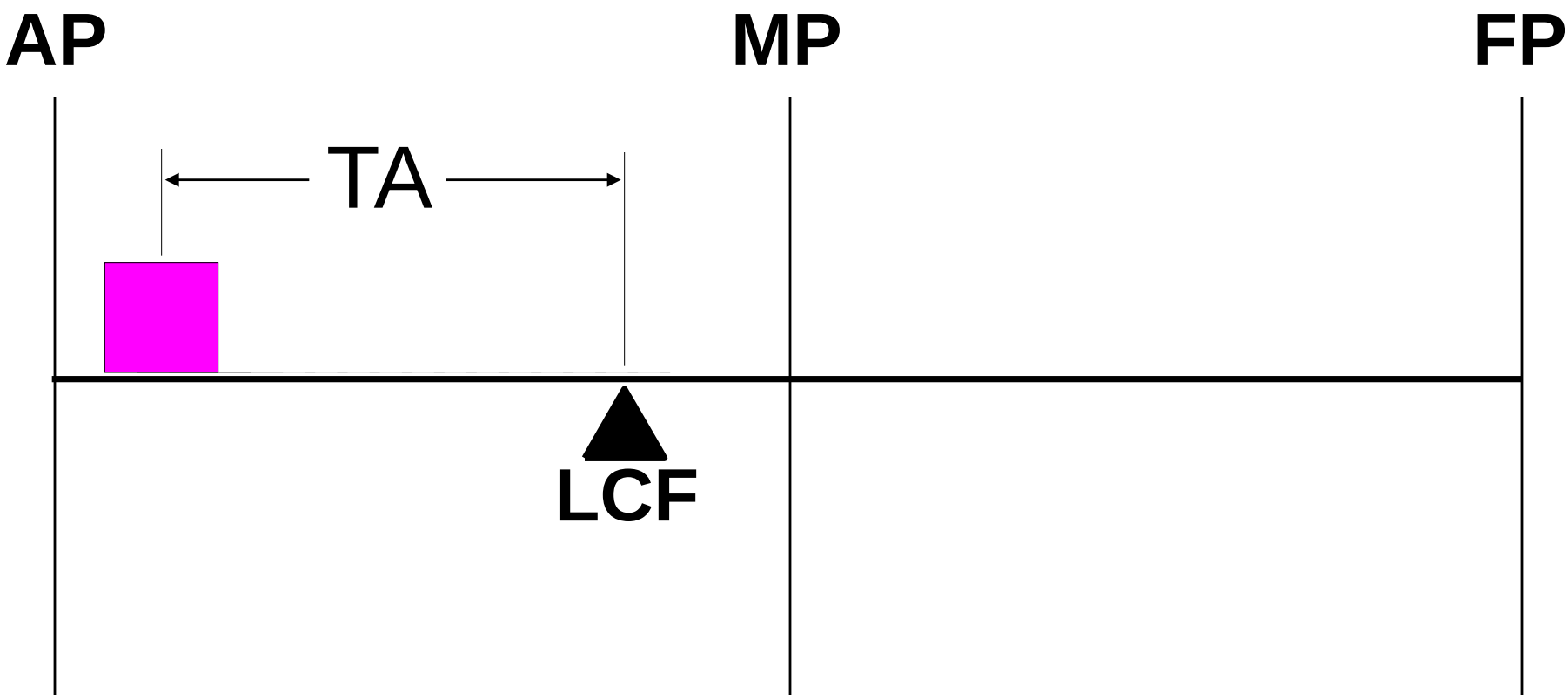
Parallel Rise (PR) is the distance that the drafts fore and aft **decrease** due to a weight removal.

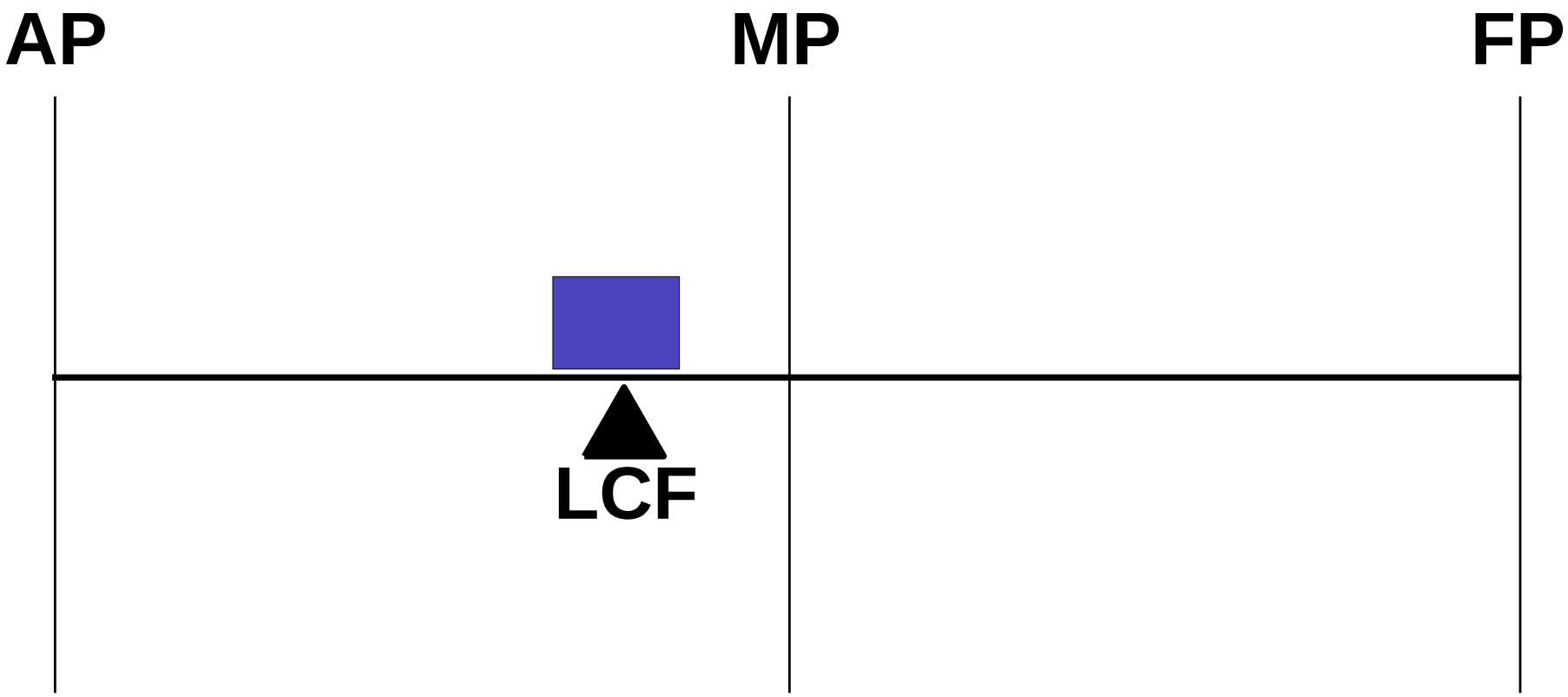
PARALLEL RISE = $\frac{-w}{TPI}$

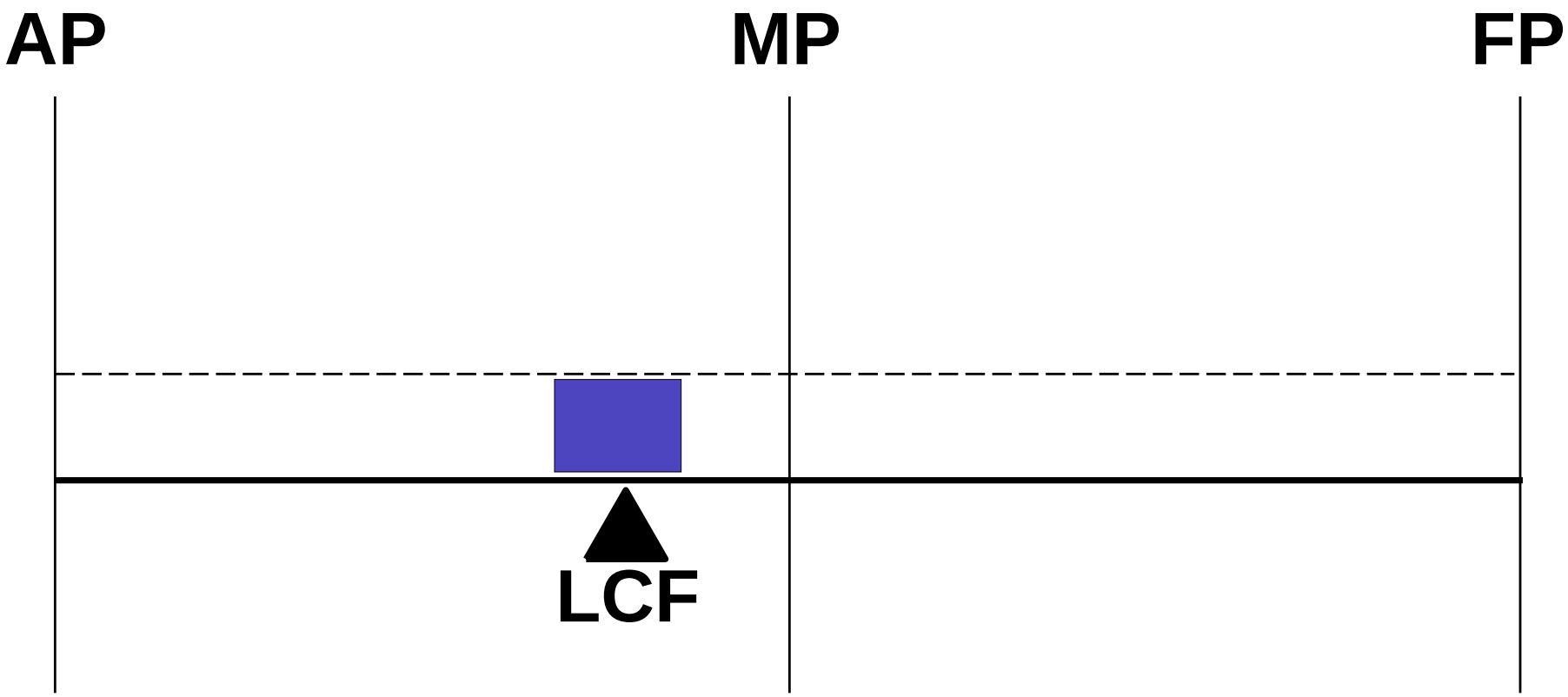
Any weight addition can be equated to an addition at LCF and a shift to its final location.



For a weight addition the Trimming Arm (TA) is equal to the distance from LCF to the center of the weight




AP
MP
FP
LCF


AP
MP
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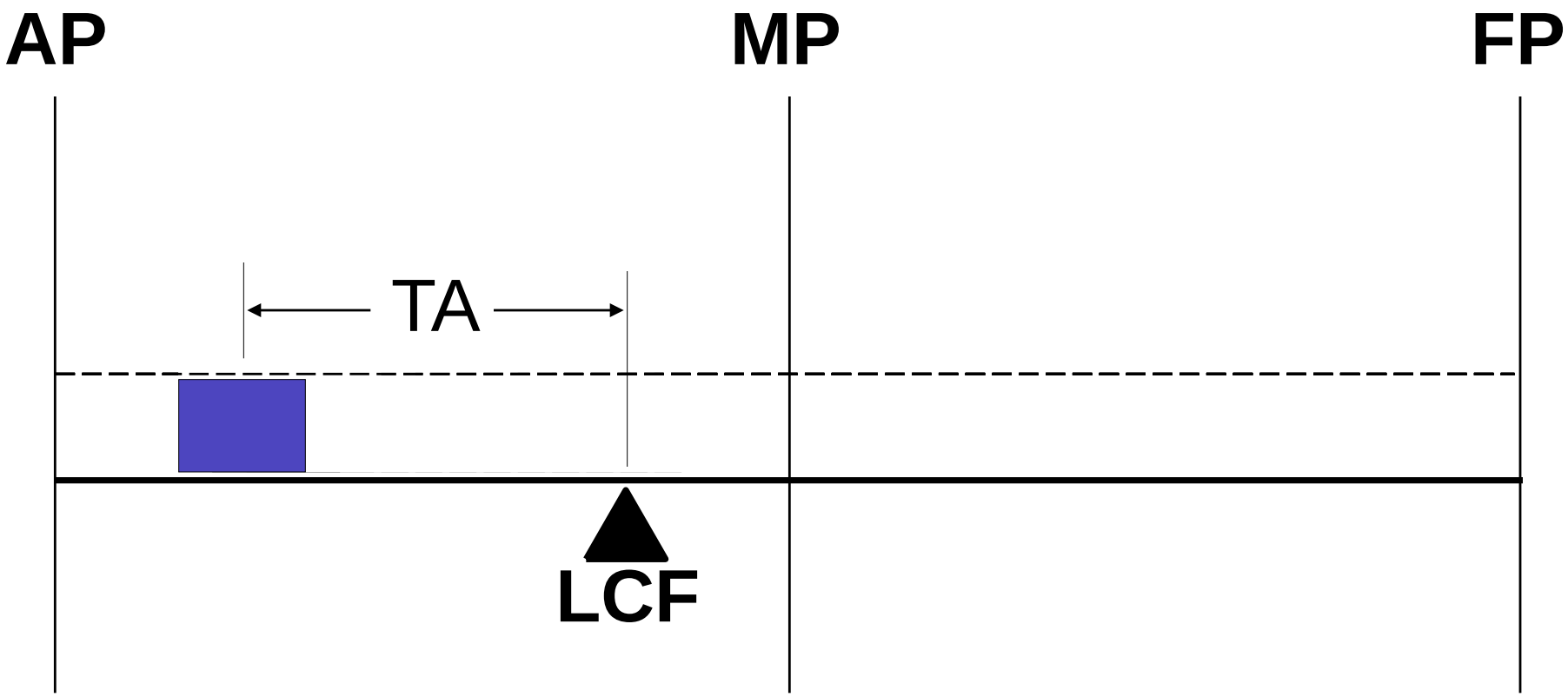
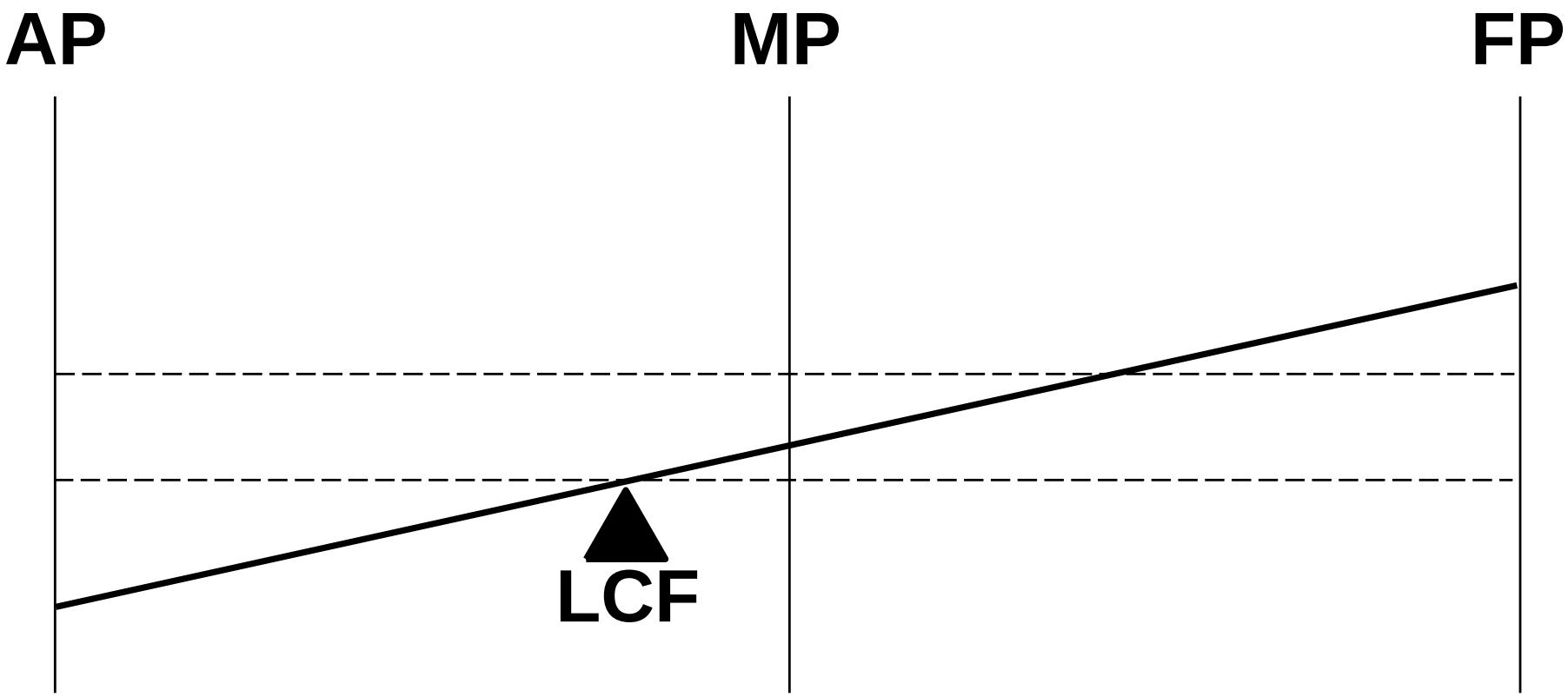
LCF


AP
MP
FP
TA
LCF


AP
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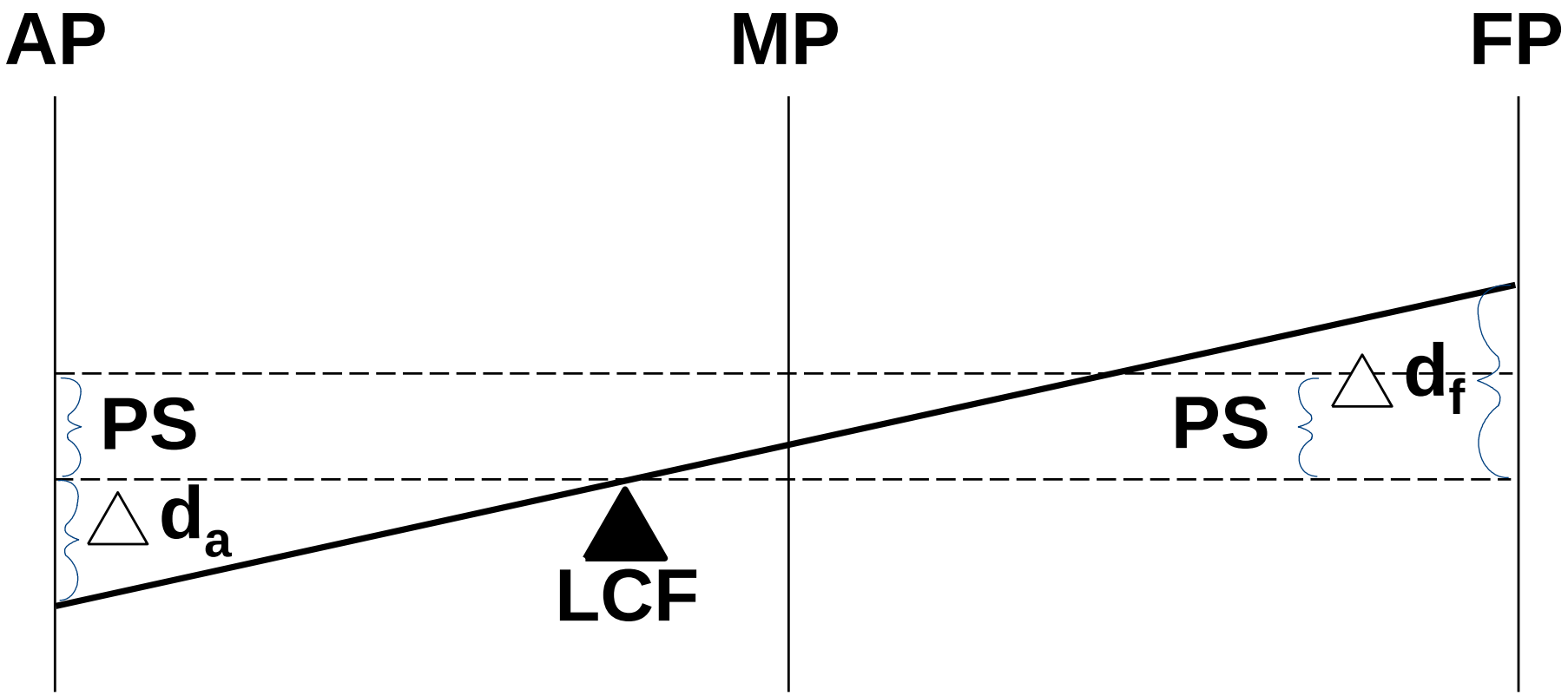
FP
LCF

TOTAL △DRAFT = PS/PR + △$d_{f\ or\ a}$



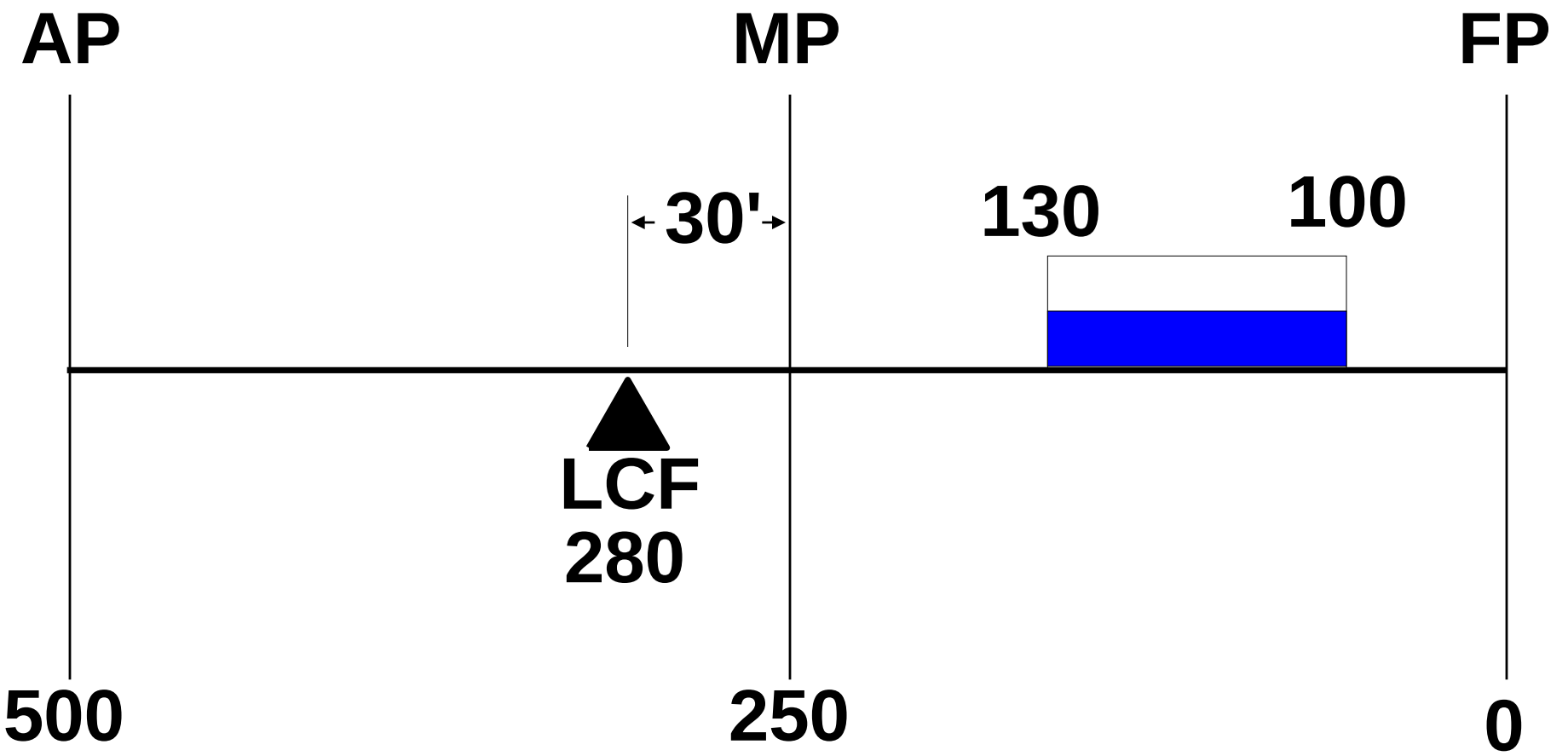
Class Topics

- ~~Longitudinal Stability Terms~~
- ~~Drag / Trim~~
- ~~Longitudinal Weight Shifts~~
- ~~Longitudinal Weight Adds/Removals~~
- Examples

COMPT # 3-100-0-L

FLOODED TO A DEPTH OF 6 FT

B = 24 FT
L = 30 FT
H = 12 FT

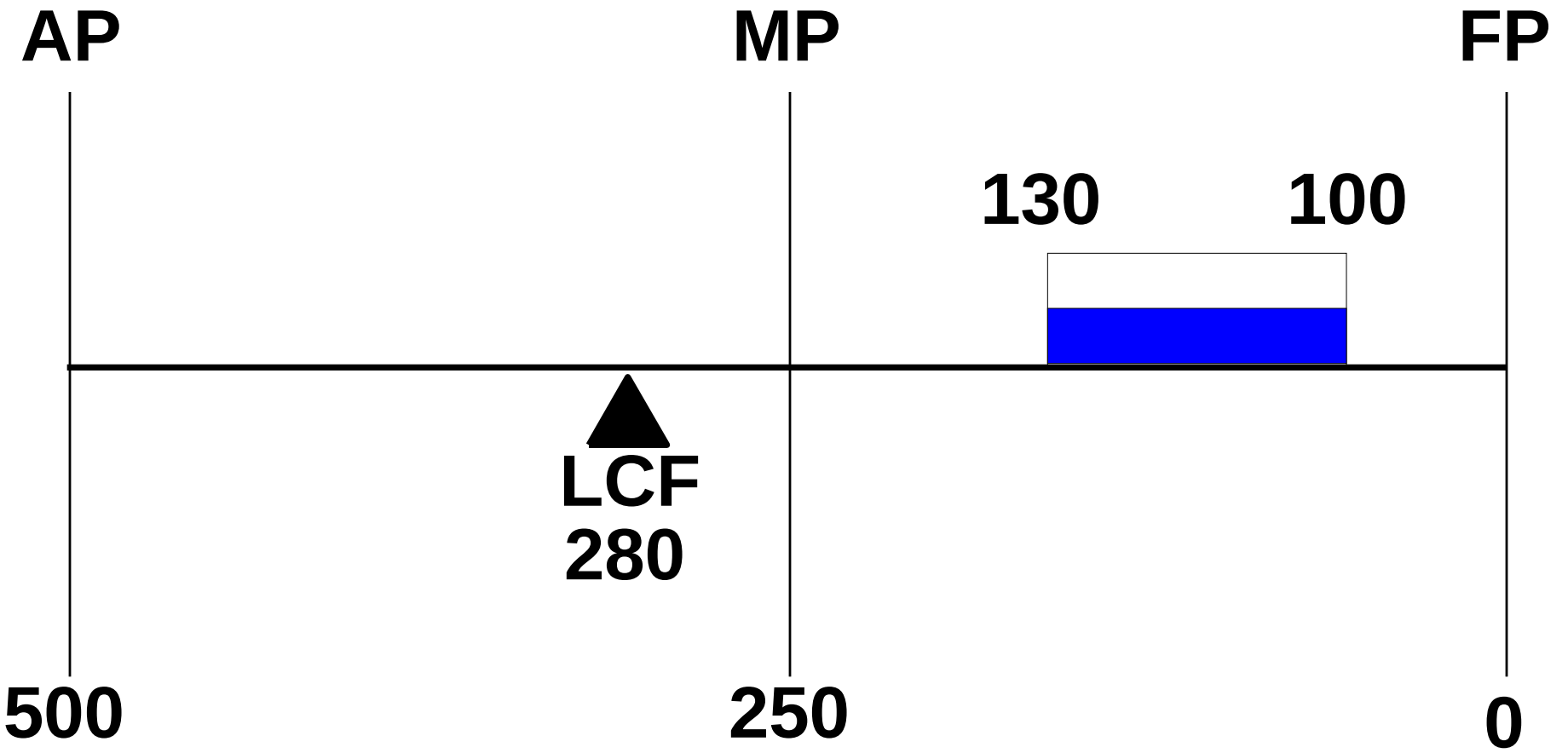


$$W_{flooding} = \frac{B \times L \times D}{35} = 123.4\ T$$

B = 24 FT
L = 30 FT
D = 6 FT

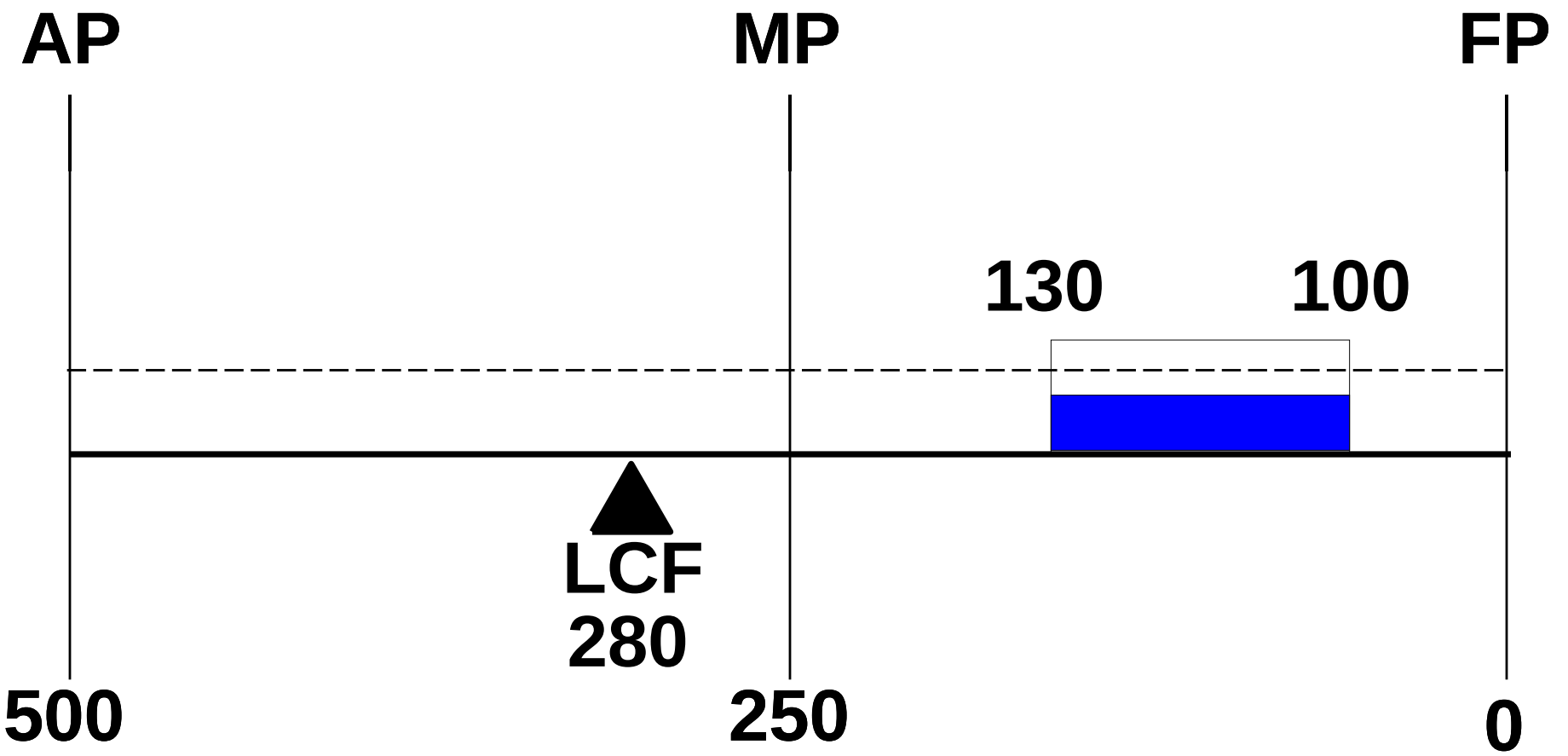
$W_o = 4500\ T$

$W_f = 4623.4\ T$



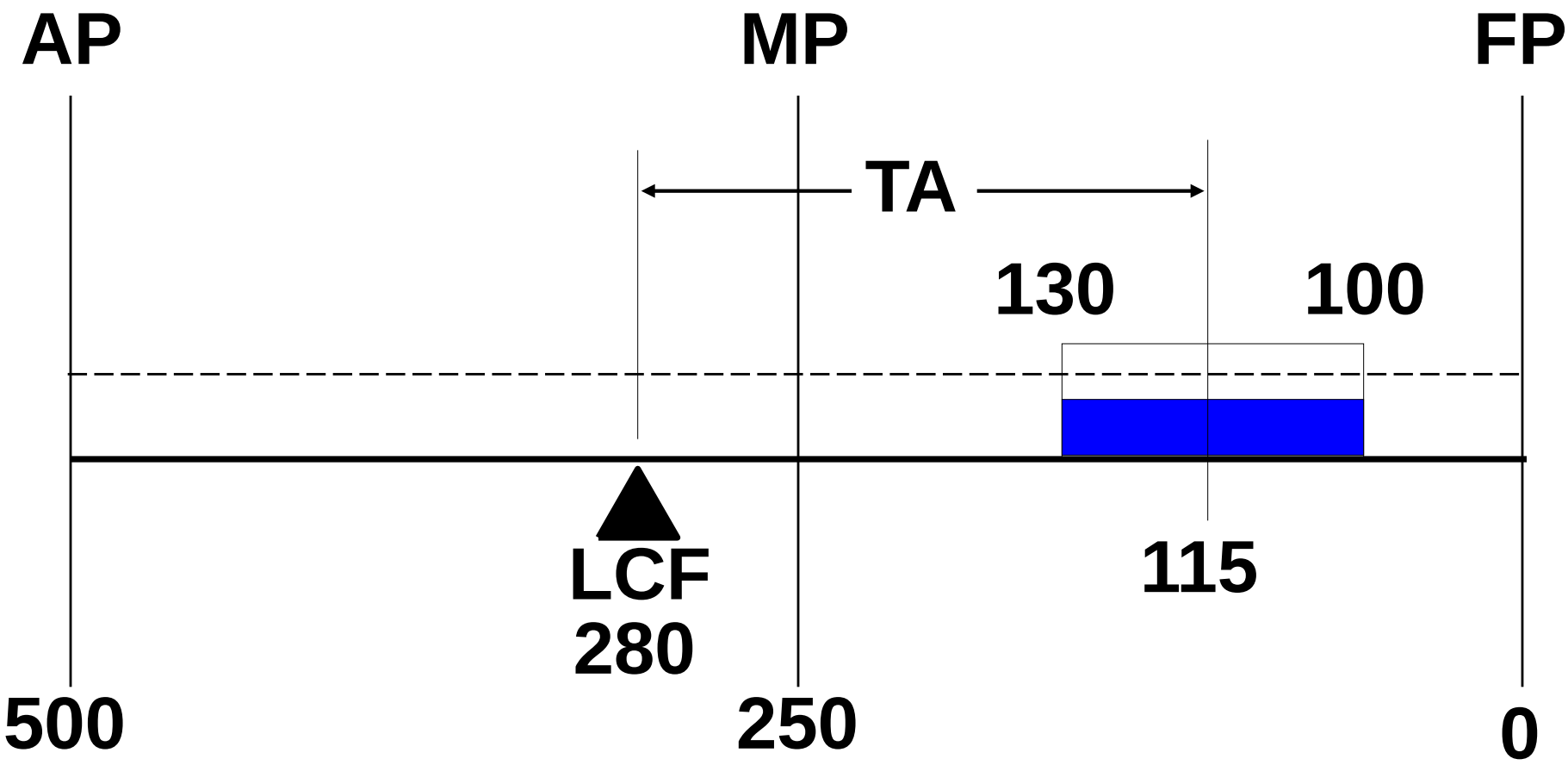
TPI = 40 T/IN

$$PS = \frac{w}{TPI} = \frac{123.4\ T}{40\ T/IN} = 3.09\ IN$$



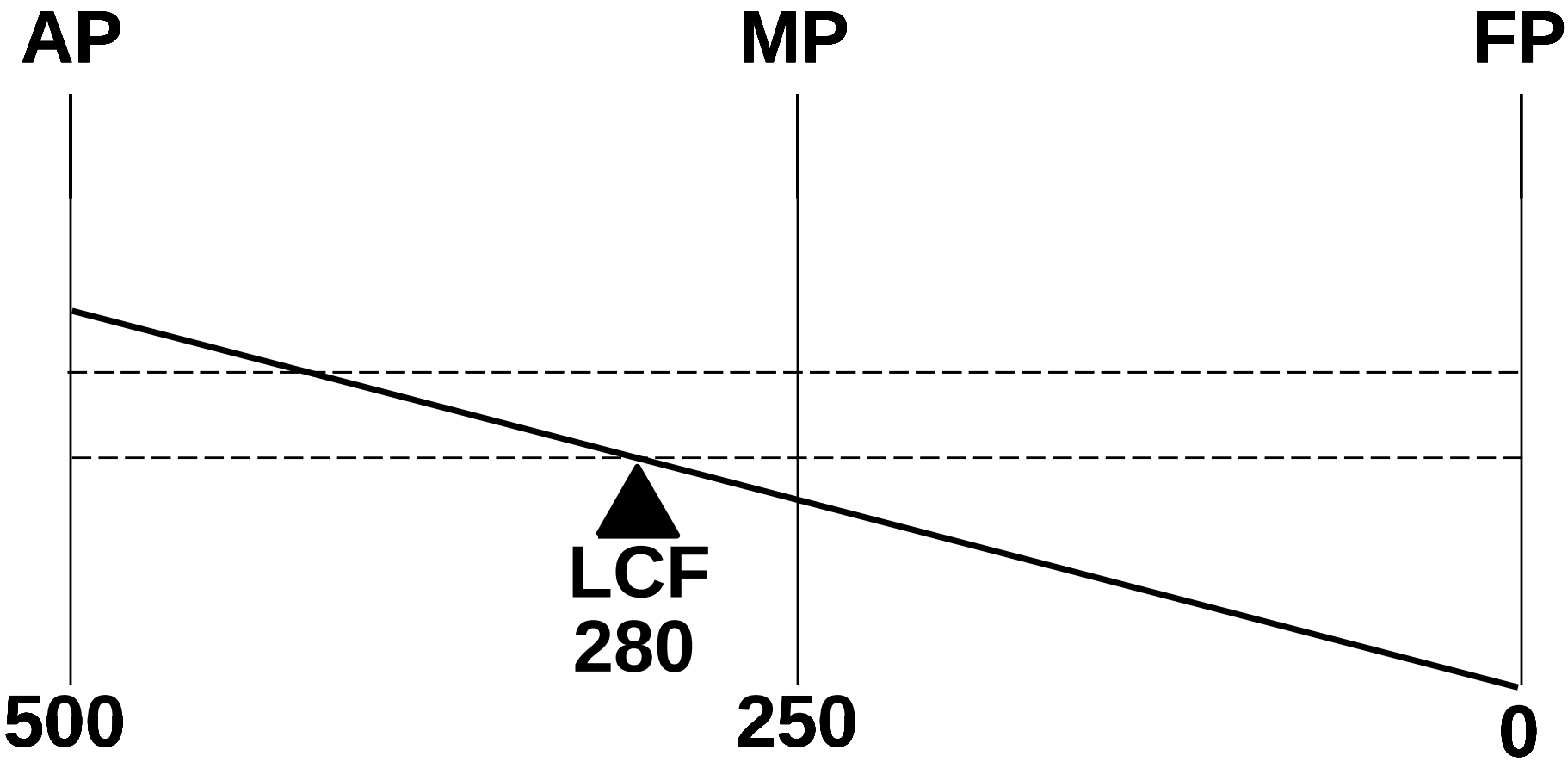
TA = 280 - 115 = 165 FT

TM = 165 FT x 123.4 T = 20361 FT-T



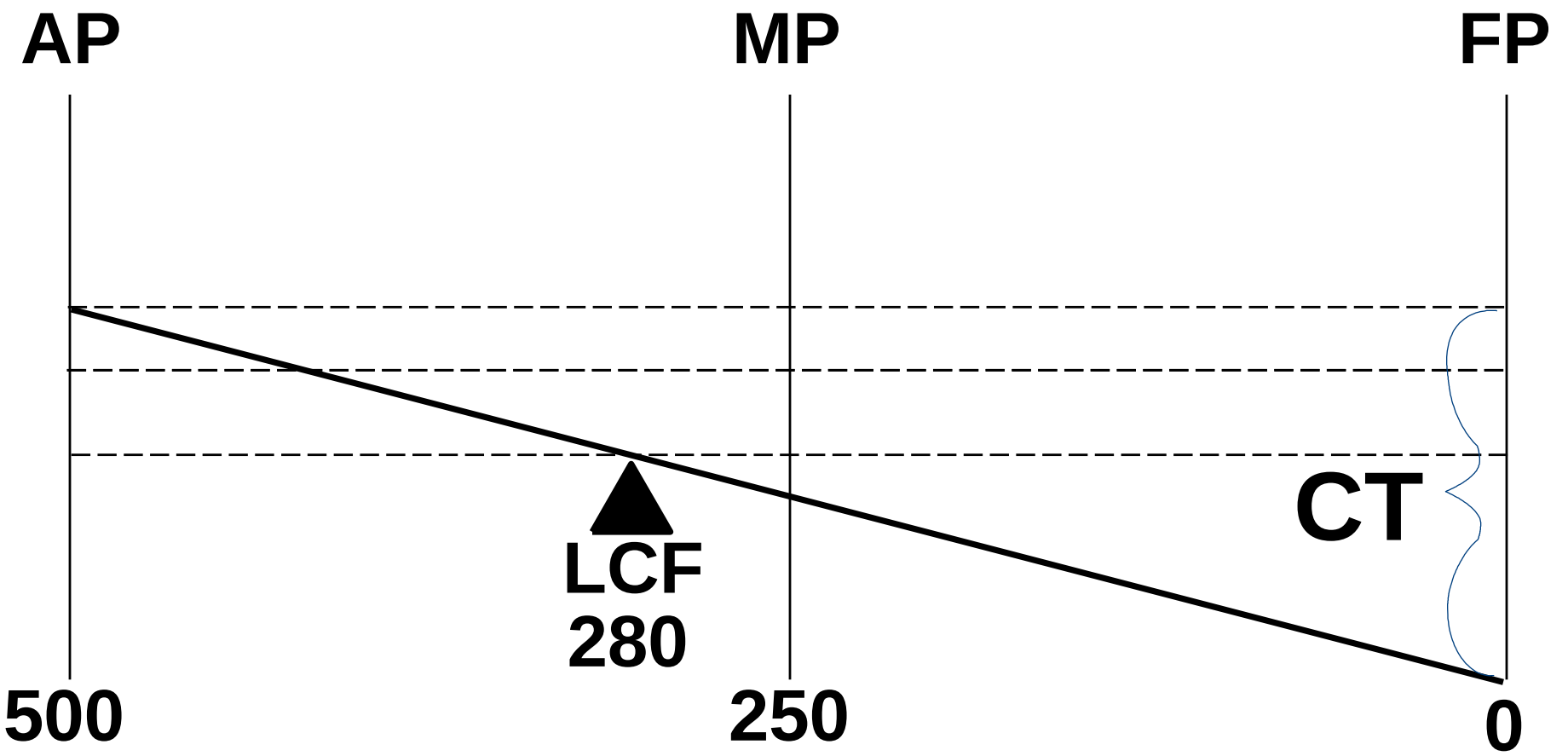
TA = 280 - 115 = 165 FT

TM = 165 FT x 123.4 T = 20361 FT-T



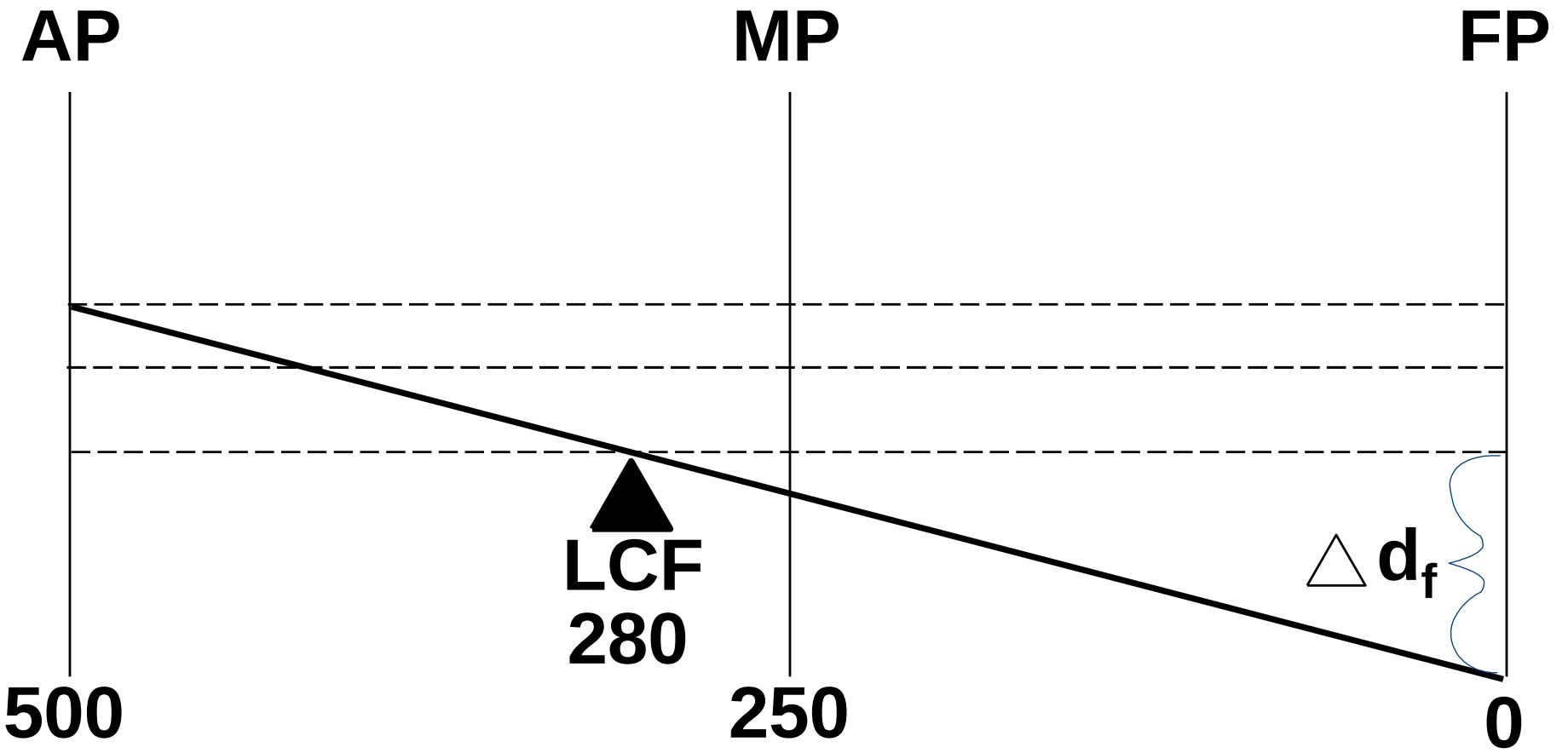
$$MT1" = 1050 \text{ FT-T/IN}$$

$$CT = \frac{TM}{MT1"} = \frac{20361 \text{ FT-T}}{1050 \text{ FT-T/IN}} = 19.39 \text{ IN}$$



$$\triangle d_f = \frac{(LBP/2 + LCF)\ x\ CT}{LBP}$$

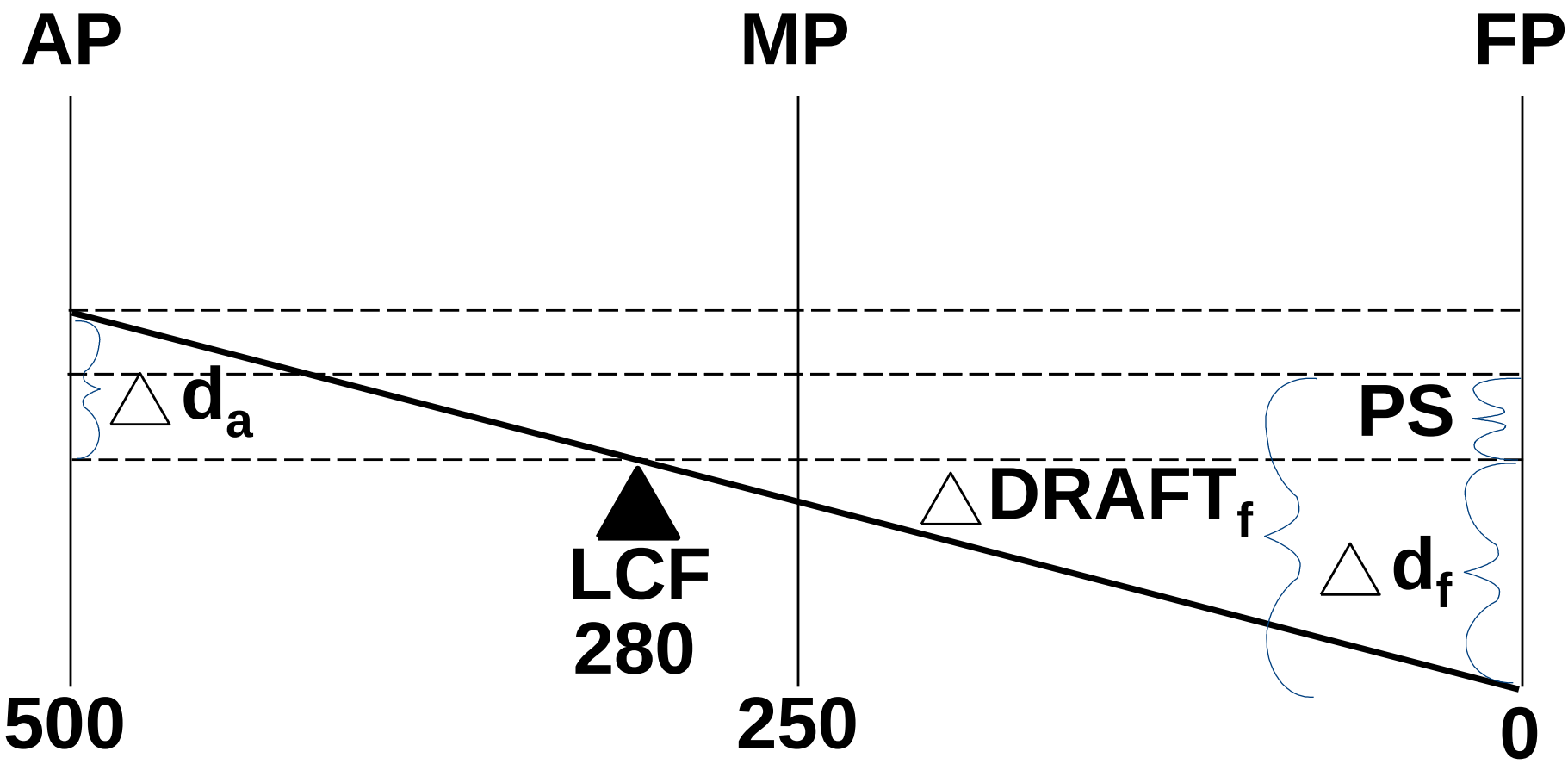
$$= \frac{(250 + 30)\ x\ 19.39}{500} = 10.86\ IN$$



$\triangle d_a = CT - \triangle d_f = 19.39 - 10.86 = -8.53$ IN

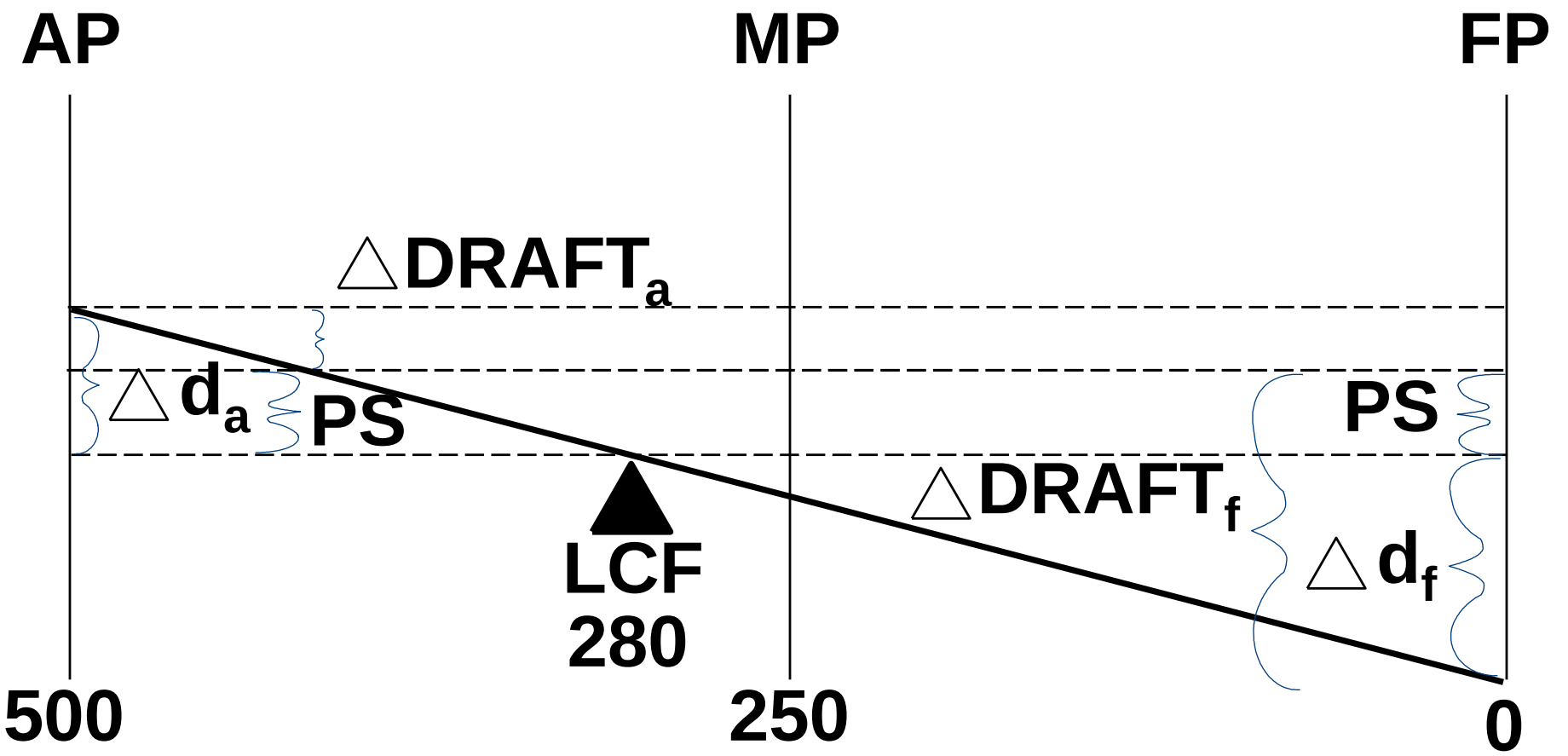
$\triangle DRAFT_f = PS + \triangle d_f = 10.86 + 3.09$

$= 13.95$ IN



$\triangle DRAFT_a = PS + \triangle d_a = 3.09 - 8.53$

$= -5.44$ IN



Summary…

- Excessive trim and loading affect intact stability.
- Drag, trim, trimming arm, trimming moment, PR/PS, plunging, and LCF.
- Impact of longitudinal weight shifts, additions, and removals on ship’s trim and drafts.
- Movement of reference points.

Quiz…

- **About what stability reference point will the ship Trim about?**
- ➢ **ANS: Longitudinal Center of Flotation (LCF).**
- **What is Drag?**
- ➢ **ANS: Designed ship characteristic with differences in drafts to increase plant effectiveness.**
- **What is Trim?**
- ➢ **ANS: Difference between drafts.**

Bonus Quiz Question…

- **What ship systems can we use to correct TRIM?**

➢ **ANS: Ballast Systems, Fuel Transfer Systems, dry load shifting.**

Instructor will now…

- Hand out stability Homework #3. DUE Tomorrow MORNING
- Assign Homework for lesson 4.4 (Stability Problems #8, #11.)
- **Read Student Guide!!**