Pengujian Sistem Ventilasi

Disusun oleh:
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AGENDA PEMBAHASAN

- Purpose
- Initial & Periodical Testing
- Volumetric, Pressure & Air Velocity Measurement

OSHS Rule 1093.
Ventilation and Exhaust Equipment

Ventilation and exhaust equipment shall be **tested** periodically for safe and efficient operational performance.

Importance of Testing Ventilation Systems

1. Acceptance tests, conforming with **system specs**
2. Compliance to safety and health **regulations**
3. Determining appropriate air velocities
4. Providing recommendations for the purpose of protecting workers (from exposure to hazardous contaminants)

Testing of Ventilation System

Purpose:

- To **verify** the **volumetric flow rate(s), fan static pressure, fan speed, motor speed, motor amperes, and the temperature** of the air in the system
- ❖ To **check the performance** of the system periodically
- ❖ To obtain specific information and **compare with design data** (drawing, etc)
- ❖ To **set baseline** for periodic maintenance checks
- ❖ **Basis for design of future** installations where satisfactory air contaminant control is currently being achieved
- ❖ To meet governmental or **regulatory requirements** for certain types of processes

Types:

- ❖ **Initial** testing
- ❖ **Periodic** testing

Example : Regulation for mirror process

Regulation of Health Minister No : 70 Year 2016

STANDARDS AND REQUIREMENTS FOR ENVIRONMENTAL HEALTH WORKING INDUSTRY

(In Workplace Area)

Table 13: Chemical Material Treshold Value

No.	Parameter	Chemical Formula	CAS Number	Notation	Treshold Value					
					TWA		STEL		Ceiling (C)	
					ppm	mg/m3	ppm	mg/m3	ppm	mg/m3
1	Ethyl alcohol (Ethanol)	C2H5OH	64-17-5	A3, Upper Respiratory Tract (URT) Irritation	1000					
2	Methyl alcohol (Methanol)	CH3OH	67-56-1	Skin, Biological Exposure Indices (BEI), Headache, Eye damage, Dizziness, Nausea	200		250			
3	Isopropyl alcohol (2-Propanol)	CH3CH(OH)CH3	67-63-0	A4, Biological Exposure Indices (BEI), Eye & Upper Respiratory Tract (URT) Irritation, Central Nervous System (CNS) Impairment	400		500			

Remark :

CAS : **Chemical Abstracts Service**

TWA : **Time Weighted Average**

is the exposure value or the intensity of the weighted average of the time at work that can be accepted by virtually all workers without cause health problems or disease, in the daily work for a period not exceeding 8 hours per day and 40 hours per week

STEL : **Short Term Exposure Limit**

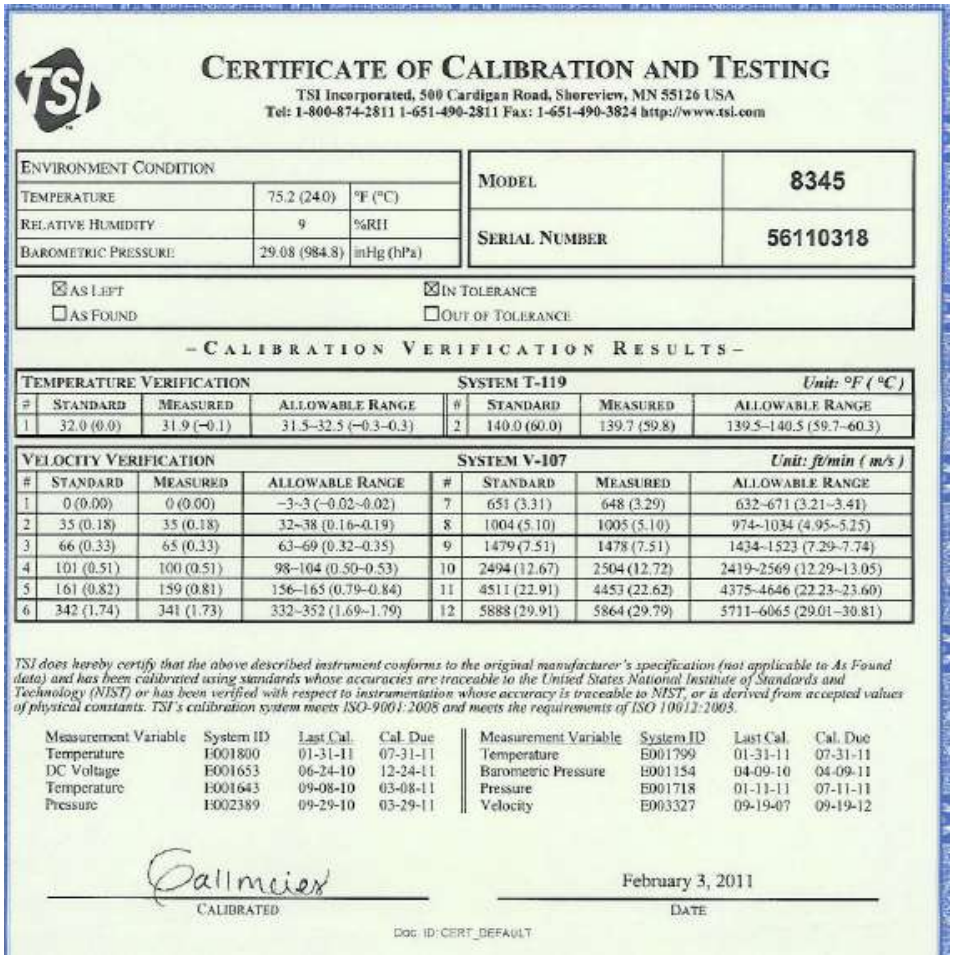
is the exposure value of the highest average within 15 minutes is allowed and should not occur more than four times, with an exposure period of at least 60 minutes for a worker to do his job within 8 working hours per day

Ceiling is the exposure value or the intensity of hazards in the workplace factor which should not be exceeded during work hours

Ventilation testing kit

- TSI Air Velocity Meter Model 8345
- Label Stickers pass/fail
- Pens
- Do not use ribbon
- Tape
- Razorblade (in holder)
- Replacement blades
- Calibration procedure
- TSI monitor procedure (for fume hood controls)
- Tape measure
- Caution Do Not Use Tape

TSI 8345 Velocity Meter calibration



CERTIFICATE OF CALIBRATION AND TESTING

TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

ENVIRONMENT CONDITION		
TEMPERATURE	75.2 (24.0)	°F (°C)
RELATIVE HUMIDITY	9	%RH
BAROMETRIC PRESSURE	29.08 (984.8)	inHg (hPa)

MODEL	8345
SERIAL NUMBER	56110318

☒ AS LEFT ☐ AS FOUND
☒ IN TOLERANCE ☐ OUT OF TOLERANCE

– CALIBRATION VERIFICATION RESULTS –

TEMPERATURE VERIFICATION — SYSTEM T-119 — *Unit: °F (°C)*

#	STANDARD	MEASURED	ALLOWABLE RANGE	#	STANDARD	MEASURED	ALLOWABLE RANGE
1	32.0 (0.0)	31.9 (−0.1)	31.5–32.5 (−0.3–0.3)	2	140.0 (60.0)	139.7 (59.8)	139.5–140.5 (59.7–60.3)

VELOCITY VERIFICATION — SYSTEM V-107 — *Unit: ft/min (m/s)*

#	STANDARD	MEASURED	ALLOWABLE RANGE	#	STANDARD	MEASURED	ALLOWABLE RANGE
1	0 (0.00)	0 (0.00)	−3–3 (−0.02–0.02)	7	651 (3.31)	648 (3.29)	632–671 (3.21–3.41)
2	35 (0.18)	35 (0.18)	32–38 (0.16–0.19)	8	1004 (5.10)	1005 (5.10)	974–1034 (4.95–5.25)
3	66 (0.33)	65 (0.33)	63–69 (0.32–0.35)	9	1479 (7.51)	1478 (7.51)	1434–1523 (7.29–7.74)
4	101 (0.51)	100 (0.51)	98–104 (0.50–0.53)	10	2494 (12.67)	2504 (12.72)	2419–2569 (12.29–13.05)
5	161 (0.82)	159 (0.81)	156–165 (0.79–0.84)	11	4511 (22.91)	4453 (22.62)	4375–4646 (22.23–23.60)
6	342 (1.74)	341 (1.73)	332–352 (1.69–1.79)	12	5888 (29.91)	5864 (29.79)	5711–6065 (29.01–30.81)

TSI does hereby certify that the above described instrument conforms to the original manufacturer's specification (not applicable to As Found data) and has been calibrated using standards whose accuracies are traceable to the United States National Institute of Standards and Technology (NIST) or has been verified with respect to instrumentation whose accuracy is traceable to NIST, or is derived from accepted values of physical constants. TSI's calibration system meets ISO-9001:2008 and meets the requirements of ISO 10012:2003.

Measurement Variable	System ID	Last Cal.	Cal. Due	Measurement Variable	System ID	Last Cal.	Cal. Due
Temperature	E001800	01-31-11	07-31-11	Temperature	E001799	01-31-11	07-31-11
DC Voltage	E001653	06-24-10	12-24-11	Barometric Pressure	E001154	04-09-10	04-09-11
Temperature	E001643	09-08-10	03-08-11	Pressure	E001718	01-11-11	07-11-11
Pressure	E002389	09-29-10	03-29-11	Velocity	E003327	09-19-07	09-19-12

Callmeier
CALIBRATED

February 3, 2011
DATE

Doc ID: CERT_DEFAULT

Recommended Procedure for Initial Ventilation Test

1) **Review** the **system specifications and drawing** to determine the relative location and **sizes** of ducts, fittings and associated system **components**.
2) Inspect the system to determine that the system installation is in accordance with the specifications and drawings. (Check fan rotation, belt slippage, and damper settings).
3) Select and identify test locations.
4) **Measure** the volumetric flow rate, fan static pressure, fan speed, motor speed, motor amperes, the temperature of the air in the system, pressure drops across coils, fittings and air cleaning equipment's.

Recommended Procedure for Initial Ventilation Test

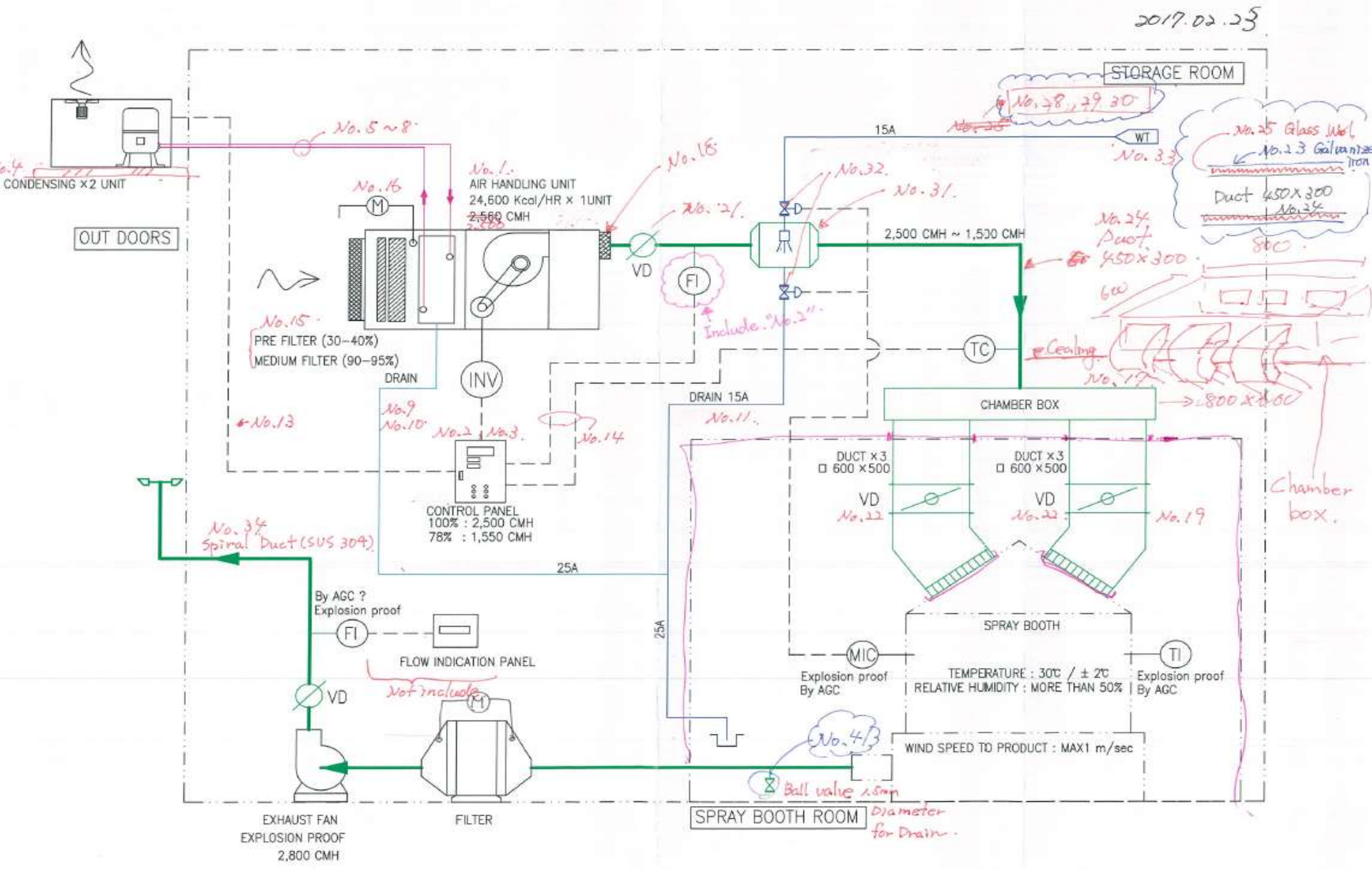
5) **record** the test data and design specifications on the data sheet.

6) **compare the test data and design specifications.**

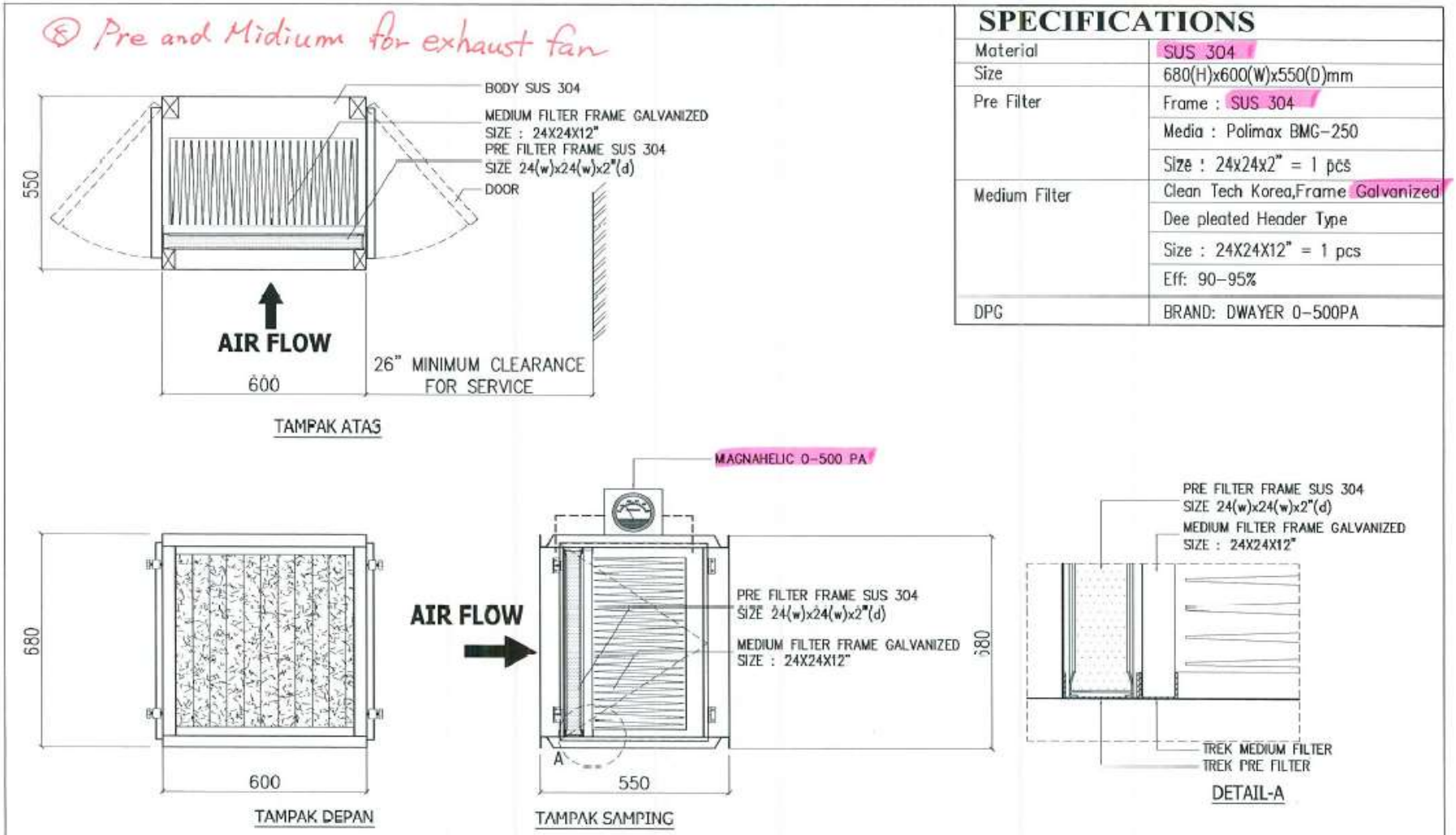
7) make necessary **amendements to meet the specifications**, codes or standards.

8) if alterations or adjustments are made, **retest** the system and record the final test data.

Example Spesification Local Exhaust Ventilation



Spesification Filter



SPECIFICATIONS	
Material	SUS 304
Size	680(H)x600(W)x550(D)mm
Pre Filter	Frame : SUS 304
	Media : Polimax BMG-250
	Size : 24x24x2" = 1 pcs
Medium Filter	Clean Tech Korea,Frame Galvanized
	Dee pleated Header Type
	Size : 24X24X12" = 1 pcs
	Eff: 90-95%
DPG	BRAND: DWAYER 0-500PA

PT. BERKATMAS MULIA GUNA
Ruko Villa Melati Mas, Blok SR 15/29
Serpong, Tangerang 15323 - Indonesia
Phn: +62-21-70956889 , Fax: 021-5378674

PROYEK / PROJECT: ASAHIMAS ANCOL
PEMILIK / CLIENT: PT. ASAHI SYNCHROTECH INDONESIA

TAHAP PEKERJAAN / DESIGN STAGE: FOR QUOTATION
GAMBAR / DRAWING: HOUSING PRE MEDIUM FILTER
SIZE : 680(H)X600(W)550(D)
Cap : 2800 CMH
QTY : 1 UNIT

TGL/DATE: 07.03.2017
REV. 1
REV. 2
REV. 3
NOMOR / NUMBER:
SKALA / SCALE:

PERENCANA / DESIGNED: RK
DIGAMBAR / DRAWN: IPL
DIPERIKSA / CHECKED: MS
DISETUJUI / APPROVED:

Recommend Procedure for Periodic Testing:

1) **Refer to the initial data** sheet for test locations.
2) **Inspect** the system for physical damage (broken, corroded, collapsed duct) and proper operation of components (fan, damper, air cleaner, controls, burner etc.).
3) **Measure static pressure** at the same locations used in the initial test.
4) **Compare** measured static pressures with initial test.
5) make and record any **correction** required.
6) **recheck** the system to verify performance.

Measurement of Volumetric Flow Rate:

Volumetric Flow Rate:

Q = V * A

Where:

V = average air velocity and

A = average cross-sectional area

Important parameter to measure is Average air velocity

Pressure Measurement:

At any point in the exhaust system, three air pressures exist

TP = SP + VP

Where:

TP = Total Pressure in “wg

SP = Static Pressure in “wg

VP =Velocity Pressure in “wg

Taking the Face Velocity Reading

- Use a calibrated **anemometer** to take the velocity measurement at the face of the ventilation opening.
- Slowly move the probe around the face of the opening until the highest face velocity is reached
- Document the highest consistent face velocity.

Pressure Measurement

Static Pressure:

- Pressure which tends to burst or collapse a duct
- Positive when > atmospheric
- Negative when < atmospheric

Instruments Used for Measurements:

- Simple Piezometer
- Simple U-tube Manometer filled with oil or appropriate liquid
- Water gauge
- Reading pressure gauge
- Inclined manometer gives increased accuracy and permits reading of lower values of velocities

Instruments Used for Pressure Measurements

U-Tube Manometer:

- **Simplest type** of pressure gauge.
- Calibrated in inches of water gauge.
- Fluid used are alcohol, mercury, oil, water, kerosene and special manometer fluids.
- Can be used for both portable and stationary applications.
- Usually made of plastic, to minimize breakage.

Inclined Manometer:

- One leg of the U-tube is tilted for scale magnification.
- **Increased sensitivity.**
- In commercial version, only one tube of small bore is used and other leg is replaced by a reservoir.
- Accuracy of the gauge is dependent on the slope of the tubes.

Instruments Used for Pressure Measurements

Aneroid Gauges:

- Used as field instrument to measure static, velocity, or total pressure with a Pitot tube or for single tube static pressure measurements.
- **Suitable for the measurements of low pressures.**
- **Easy to read, portable, and greater response than manometer types**.
- Absence of fluid means **less maintenance**.
- Mounting and use in any position is possible without loss of accuracy.

Instruments Used for Pressure Measurements

Electronic Aneroid Gauges:

- Measures and records static pressure as well as integrate velocity pressure directly to velocity.
- Uses the principle of pressure sensing.
- **Can be equipped with digital display or print recorder** with measurement data in either English or S.I units.

Hood Static Pressure

Hood Static Pressure:

- Method of estimating air flow into an exhaust hood or duct is based on the principle of the orifice.
- Method is **quick, simple and practical.**

Procedure of Measurement:

- This technique involves the measuring of hood static pressure by means of a U-tube manometer at one or more holes.
- The manometer is connected to each hole in turn by means of a thick walled soft rubber tube.
- The difference in height of the water columns is read in inches.
- After hood static pressure (SP_h) is known, the volumetric flow rate is determined as.

Equation for Flow Rate

$Q = 4005 * A * C_e * \sqrt{SP_{h.}}$

Where:

Q = flow rate in fpm.

A = Average cross-sectional area in sqft.

C_e = Coefficient of entry loss.

SP_h = Static pressure in the hood or the duct.

Points to Remember while Measuring Pressure:

- Avoid pressure measurement at the heel of an elbow or other location.
- Drill 2-4 pressure holes at uniform distances around the duct and obtain the average.
- Hole should be drilled not punched.
- When in use, the instrument must be pointed upstream and parallel to the duct for accurate measurement.

Velocity Pressure

- To measure velocity pressure and velocity of flow Pitot tube is used.
- The device consist of two concentric tubes.
- One measures the total or impact pressure existing in the air stream.
- Other measures the static pressure only.
- The annular space and center tube are connected across a manometer. The velocity pressure is indicated on the manometer.
- The velocity of air stream for standard conditions is determined as.

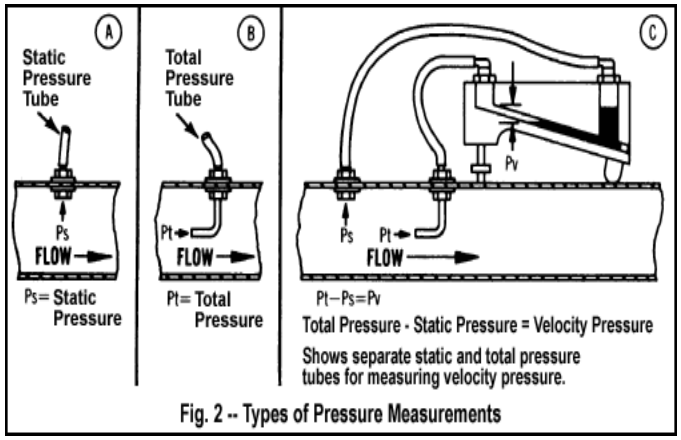


Fig. 2 -- Types of Pressure Measurements

For other then standard conditions, equivalent velocity pressure

$VP_e = VP_m / df$

Where

VP_e = equivalent velocity pressure in "w

VP_m = measured velocity pressure "wg

df = density correction factor

Pitot Traverse Method:

- Method to select points along the duct cross-section to measure the velocity pressure
- Usual method is to make two traverses across the diameter of the duct at right angles to each other
- Readings are taken at the center of annular rings of equal area as shown in the figure

Pitot Traverse Method

For Circular ducts:

- 6'' and smaller - minimum 6 traverse points.
- 6'' and larger - minimum 10 traverse points.

For Square and Rectangular ducts:

- Divide the cross-section into a number of equal rectangular areas.
- Measure the velocity pressure at the center of each area.
- Minimum 16 readings should be taken.

Essential Data to Be Collected:

- The area of the duct at the traverse location.
- Velocity pressure at each point in the traverse.
- Temperature of the air stream at the time and location of the traverse.

Important Points to Consider

- The velocity pressure reading obtained are converted to velocities and the velocities, not the velocity pressure, are averaged.
- The square root of each of the velocity pressure may be averaged and this value then converted to velocity (average).
- Pitot tube is not suitable for measuring velocities less than 600 fpm.

Air Velocity Measuring Instruments

1) Rotating vane anemometer
2) Swinging vane anemometer
3) Thermal anemometer
4) Smoke tubes
5) Tracer gas method
6) Pitot tubes

Rotating Vane Anemometer

- Used to determine air flow through **large supply and exhaust openings.**
- Cross-sectional area of the instrument not greater than 5.0% of the cross-sectional area of the duct or hood opening.
- Used for either **pressure or suction** measurements.
- Is useful for a range **of 200 - 300 fpm.**
- Readings as low as 25 fpm can be measured and recorded using electronic type.

Swinging Vane/Thermal Anemometer

Swinging Vane Anemometer:

- Used for field measurements.
- **Highly portable, has wide scale range and gives instantaneous readings**.
- Minimum velocity measured is 50 fpm, unless specially adapted for lower range.

Thermal Anemometer.

Principle: Amount of heat removed by an air stream passing a heated object is related to the velocity of the air stream.

Components: Velocity sensor & Temperature sensor.

Tracer Gas Method

- Tracer gas is metered continuously into one or more intake ports along with entering air stream.
- Air samples are collected at some point downstream.
- The concentration of tracer gas in the exit stream is determined.
- The rate of air flow equals the rate of feed divided by tracer gas concentration.

Calibration of Air Measuring Instruments

Need: Easily impaired by shock (dropping, jarring), dust, high temperature and corrosive atmosphere.

Calibrating Wind Tunnel Components:

1) A Satisfactory test section:
   - ❖ Section where the sensing probe or instrument is placed.

2) A Satisfactory means for precisely metering the airflow:
   - ❖ The meter on this scale must be accurate and with large enough scale graduation (precision + 1%).

3) A means of regulating and effecting air flow through the tunnel:
   - ❖ The regulating device must be easily and precisely set to the desired velocities.
   - ❖ Fan must have sufficient capacity to develop maximum velocity.

Difficulties Encountered in Field Measurement

- Measurement of air flow in highly contaminated air which may contain corrosive gases, dusts, fumes, mists, or products of combustion.
- Measurement of air flow at high temperature.
- Measurement of air flow in high concentrations of water vapor and mist.
- Measurement of air flow where the velocity is very low.
- Measurements of air flow in locations of turbulence and non-uniform air flow.
- Measurement of air flow in connection with iso-kinetic sampling when the velocity is constantly changing.

Summary Ventilation testing kit

No	Parameter	Tools	Picture
1	volumetric flow rate(s),	Airflow / anemo meter 	
2	static pressure,	Pitot tube & Manometer	
3	fan speed,	Revolution counter & watch Tachometer	 
4	motor speed,		
5	motor amperes,	Amperemeter / Ammeter	
6	temperature of the air in the system	Termometer	

Terima kasih &
Sampai Jumpa di Pertemuan Selanjutnya