

Fujitsu Enterprise Postgres 18
for Kubernetes

Reference Guide

Linux



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Preface

Purpose of this document

This document is a reference, and explains parameter.

Intended readers

This document is aimed at people who manage and operate.

Readers of this document are also assumed to have general knowledge of:

- Linux
- Kubernetes
- Containers
- Operators

Structure of this document

This document is structured as follows:

[Chapter 1 Custom Resource Parameters](#)

Explains the parameter.

[Appendix A Default Metrics Queries](#)

Explains the Default Metrics Queries

[Appendix B Default Alert Rules](#)

Explains the Default Alert Rules

[Appendix C Operator Operation Event Notification](#)

Explains the Operator Operation Event Notification

Abbreviations

The following abbreviations are used in this manual:

Full Name	Abbreviations
Fujitsu Enterprise Postgres for Kubernetes Fujitsu Enterprise Postgres	FEP
Transparent Data Encryption	TDE
Custom Resource	CR
Custom Resource Definition	CRD
Persistent Volume	PV

Abbreviations of manual titles

The following abbreviations are used in this manual as manual titles:

Full Manual Title	Abbreviations
Fujitsu Enterprise Postgres for Kubernetes User's Guide	User's Guide

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Chapter 1 Custom Resource Parameters

This chapter explains the parameter.

1.1 FEPCluster Parameter

Equivalent Kubernetes command: `kubectl apply -f FEPClusterCR.yaml`

This operation will create a FEPCluster with supplied information in FEPClusterCR.yaml.

Initial configuration and subsequent changes to FEP Cluster are done through FEP Cluster CR.

Field	Default	Details
metadata.name	new-fep	<p>Name for the Cluster. FEP server container will use this value for Patroni scope.</p> <p>e.g. new-fep</p> <p>Enter a string of up to 24 characters.</p> <p>You cannot change the name after it has been created. If you need to change it, please create a new one.</p>
spec.fep.autoPodRestart	<omitted>	<p>Optional</p> <p>This parameter affects the behaviour when value(s) of CPU, memory and/or image for FEP and/or optional Backup container are updated in FEPCluster CR.</p> <p>If it is NOT defined and set to true, operator will automatically create an action CR to make values effective by restarting all pods in an orderly fashion to minimise outage.</p> <p>If it is set to false, automatic restart of PoDs will NOT happen. To make the changes effective, user must restart pods by creating action CR with type 'pod_restart' and arguments 'ALL'</p>
spec.fep.fepVersion	<omitted>	<p>Optional</p> <p>When deploying a new FEP cluster, this parameter controls which FEP major version will be used for the deployment.</p> <p>If not specified, Operator will use latest FEP version supported by the Operator.</p> <p>When fepVersion is defined but not spec.fep.image.image, Operator will deploy the specific version of FEP.</p> <p>When both fepVersion and image are defined, Operator will use the image and discard the value of fepVersion.</p> <p>Current support value: 14, 15, 16, 17, 18</p> <p>Note: Changing fepVersion from one version to another version is not supported after deployment.</p>

Field	Default	Details
spec.fep.customAnnotations.allDeployments	{ } (*)	Contents under this are optional. User can remove { } and add multiple key-value pairs. All of these pair will be added to annotations of FEP statefulSet and FEP Pods. If left at default, no annotation is added to Pods and statefulSets
spec.fep.image.image	<omitted>	FEP server container image to be used quay.io/fujitsu/fujitsu-enterprise-postgres-18-server:ubi9-18-1.0 It is optional Image line is omitted by default. This key has a higher precedence than fepVersion. If both fepVersion and image are omitted, Operator will use the latest FEP version that it supports. If both fepVersion and image are specified, Operator will use the specified image and ignore the value in fepVersion.
spec.fep.image.pullPolicy	IfNotPresent	
spec.fep.image.pullSecrets		Define a Pullsecrets for pulling the customized images.
spec.fep.mcSpec.limits	cpu: 500m memory: 700Mi (If spec.fep.databaseSize is medium) cpu: 2 memory: 4Gi (If spec.fep.databaseSize is large) cpu: 4 memory: 16Gi	
spec.fep.mcSpec.requests	cpu: 200m memory: 512Mi (If spec.fep.databaseSize is medium) cpu: 1 memory: 2Gi (If spec.fep.databaseSize is large) cpu: 2 memory: 8Gi	
spec.fep.databaseSize		Specifiable values: small, medium, large The operator defines the values for cpu, memory, and postgresql.conf, matching the specified values. If the target parameter is defined, it is not overwritten. Can be set only when creating FEPCluster custom resource.

Field	Default	Details
		After you create a FEPCluster custom resource, you customize it by editing each parameter.
spec.fep.sysExtraLogging	false	To turn extra debugging on, set value to true It can be turned on/off at any time
spec.fep.sysExtraEvent	false	Options To turn on event notification for custom resource changes, set the value to true. You can turn it on or off at any time.
spec.fep.instances	1	Number of nodes in the cluster, including both Master and Replicas. In Example CR, it is kept at 1 for certification. However, user can change it to 3 for 1 master and 2 replicas.
spec.fep.servicePort	27500	TCP port for FEP master service
spec.fep.syncMode	off	Replication Mode: off - async replication on - sync replication Changes made after the cluster is created will not take effect.
spec.fep.standby.enable	false	This parameter enables the hot standby configuration. Enabled at true. Changes made after the cluster is created will not take effect.
spec.fep.standby.method		Specifies the method for achieving a hot standby configuration. archive-recovery - Uses continuous recovery. streaming - Uses streaming replication. Changes made after the cluster is created will not take effect.
spec.fep.standby.pgBackrestConf		Required for both continuous recovery and streaming replication methods. You must specify the backup storage on which the production environment is backed up. AWS S3 and Azure Blob Storage are available. Changes made after the cluster is created will not take effect.
spec.fep.standby.streaming.host		Specify this option to use the streaming replication method. Specify the external IP of the LoadBalancer you created in "Defining a Streaming Replication Method" in the User's Guide. Changes made after the cluster is created will not take effect.

Field	Default	Details
spec.fep.standby.streaming.port		Specify this option to use the streaming replication method. Specify the port defined in the LoadBalancer you created in "Defining a Streaming Replication Method" in the User's Guide. Changes made after the cluster is created will not take effect.
spec.fep.forceSsl	true	Controls the use of SSL only for communication between FEPCluster containers. The changes are reflected in pg_hba.conf. Changing this parameter is not reflected in pg_hba.conf if the automatic certificate generation feature is enabled. Changes made after the cluster is created will not take effect.
spec.fep.locale	<omitted> (*)	Optional Can only be specified when creating a FEPCluster. Database Cluster Locale Settings: ja_JP - Japanese locale Default - C Changes made after the cluster is created will not take effect.
spec.fep.monitoring		This is an Optional section. This defines whether monitoring enabled(true) or disabled(false) , MTLs enabled or disabled & Basic authentication enabled or not
spec.fep.monitoring.enable	false	If set true, the operator will create FEPExporter with given spec You can change the value from false to true. Changing the value from true to false will not delete the associated resources.
spec.fep.monitoring.fepExporter		This is Optional section. Exporter spec section applied only if enable: true
spec.fep.monitoring.fepExporter.authSecret		This is Optional section. Base Authentication secret to provide username & encrypted password of user
spec.fep.monitoring.fepExporter.authSecret.secretName	(created by user)	Mandatory Name of secret that contains username and password You can add or remove items later. Changes made after the cluster is created will not take effect.
spec.fep.monitoring.fepExporter.authSecret.userKey	(created by user)	Mandatory Key of username in specified secret

Field	Default	Details
spec.fep.monitoring.fepExporter.authSecret.passwordKey	(created by user)	Mandatory Key of password in specified secret
spec.fep.monitoring.fepExporter.tls		This is optional section. FEPEXporter MTLS specs. Mandatory if tls specs defined for Prometheus specs
spec.fep.monitoring.fepExporter.tls.certificateName	(created by user)	Mandatory. This points to Kubernetes TLS secret that contains the certificate of FepExporter. Prometheus will use this for certificate authentication. The certificate itself is stored in the key tls.crt.
spec.fep.monitoring.fepExporter.tls.caName	(created by user)	Mandatory This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt.
spec.fep.monitoring.fepExporter.customLabel		Optional List of key value pair to be added to Prometheus ServiceMonitor label. The following label will always be added to ServiceMonitor, regardless if a value is specified here or not. fepsmgrp: sm-fep-exporter
spec.fep.monitoring.prometheus		This is Optional section. Prometheus specs are mandatory if tls specs defined for FEPEXporter
spec.fep.monitoring.prometheus.tls		Prometheus MTLS specs
spec.fep.monitoring.prometheus.tls.certificateName	(created by user)	This is an Optional parameter. These points to Kubernetes TLS secret that contains the certificate of Prometheus. FEPEXporter will use this for certificate authentication. The certificate itself is stored in the key tls.crt.
spec.fep.monitoring.prometheus.tls.caName	(created by user)	This is an Optional parameter. This point to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt.
spec.fep.externalMonitoring.cloudWatch		This is an Optional section. Define this option when linking with CloudWatch.
spec.fep.externalMonitoring.cloudWatch.enable	true	Optional A value of true forwards Fujitsu Enterprise Postgres metrics to CloudWatch. Specify false to cancel log transfer.
spec.fep.externalMonitoring.cloudWatch.schedule	"0-59/10 * * * *"	You can specify how often to transfer. Specified as a Cron value.
spec.fep.externalMonitoring.cloudWatch.namespace		Specifies the CloudWatch Namespace to which metrics are forwarded.

Field	Default	Details
		Required if spec.fep.externalMonitoring.cloudWatch is specified
spec.fep.externalMonitoring.cloudWatch.defaultMetrics	true	Specify true to capture and forward the metrics described in "Metrics Collected by CloudWatch" in the User's Guide. Specify false to forward only custom metrics to CloudWatch.
spec.fep.externalMonitoring.cloudWatch.customMetrics		Optional If you want to forward custom metrics, specify the ConfigMap name where you defined the custom metrics.
spec.fep.externalMonitoring.cloudWatch.dimensionName		Optional If adding a Dimension, specify a name of your choice. If dimensionValue is omitted, this value is ignored.
spec.fep.externalMonitoring.cloudWatch.dimensionValue		Optional If adding a Dimension, specify any value. If dimensionName is omitted, this value is ignored.
spec.fep.externalMonitoring.cloudWatch.authentication.cloudWatchCredentials		Specify a secret name that defines a credentials for a role that has permission to forward metrics to CloudWatch. Required if spec.fep.externalMonitoring.cloudWatch is specified
spec.fep.externalMonitoring.cloudWatch.authentication.cloudWatchConfig		Specify a ConfigMap name that defines the config information for a role that has permission to forward metrics to CloudWatch. Required if spec.fep.externalMonitoring.cloudWatch is specified
spec.fep.externalMonitoring.cloudWatch.databases	postgres	Specifies the databases from which to collect metrics, in list format. The default is to collect metrics from the postgres database.
spec.fep.podAntiAffinity	false	Defines that all the pods should not run on same worker node
spec.fep.podDisruptionBudget	false	Allows to maintain minimum number of pods of an application even when some nodes are voluntarily drained for say, maintenance
spec.fep.replicationSlots		List of Patroni permanent replication slots.
spec.fep.replicationSlots.demo_subscription1		The 'demo_subscription1' is the slot name. This name cannot be same as any pod name

Field	Default	Details
		(e.g., new-fep-sts-01) in the cluster. Otherwise, the slot will not be created.
spec.fep.replicationSlots.type	logical	Must be 'logical' for logical replication
spec.fep.replicationSlots.database	postgres	Specify the database name for logical replication
spec.fep.replicationSlots.plugin	pgoutput	FEP supports 'pgoutput' by default.
spec.fep.usePodName		Optional Setting this key to true will make internal POD communication, both Patroni and Postgres to use hostname, instead of IP address. This is important for TLS as the hostname of the POD is predictable and can be used to create Server Certificate, whereas IP address is unpredictable and cannot be used to create Certificate. There is no negative effect setting this key to true even if TLS (i.e. Server Certificate) is not used. Changes made after the cluster is created will not take effect.
spec.fep.patroni.tls.certificateName	(created by user)	Optional This point to Kubernetes TLS secret that contains the certificate for Patroni. The certificate itself is stored in the key tls.crt. This field is optional. When this key is set, the Operator will ignore the value in systemCertificates Changes made after the cluster is created will not take effect.
spec.fep.patroni.tls.caName	(created by user)	Optional This points to Kubernetes configmap that contains additional CA for Patroni to verify client. The CA is stored in the key ca.crt. This field is optional. Changes made after the cluster is created will not take effect.
spec.fep.postgres.tls.certificateName	(created by user)	Optional This points to Kubernetes TLS secret that contains the certificate for Postgres. The certificate itself is stored in the key tls.crt. This field is optional. When this key is set, Operator will ignore the value in systemCertificates Changes made after the cluster is created will not take effect.
spec.fep.postgres.tls.caName	(created by user)	Optional This point to Kubernetes configmap that contains additional CA for Postgres to verify client. The CA is stored in the key ca.crt. This field is optional.

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fep.postgres.tls.privateKeyPassword	(created by user)	Optional This points to Kubernetes secret that contains the password for the above private key. This field is optional. Changes made after the cluster is created will not take effect.
spec.fep.pgAuditLog.auditLogPath		Use this value for log_directory in pgaudit.conf If pgAuditLog.auditLogPath is not defined: use '/database/log/audit' or '/database/userdata/data/log' when log volume is not defined .
spec.fep.pgAuditLog.schedules		Schedule to upload auditlog
spec.fep.pgAuditLog.schedules.upload		Upload schedule in crontab format
spec.fep.pgAuditLog.endpoint.protocol	http	Optional Default: http Supported values: - 'http' - 's3' - 'blob'
spec.fep.pgAuditLog.endpoint.url		Webserver URL to upload the auditlog files
spec.fep.pgAuditLog.endpoint.customCertificateName		Optional Secret that contains the certificate to setup communication with Web server
spec.fep.pgAuditLog.endpoint.insecure	false	Optional equivalent to curl -insecure option
spec.fep.pgAuditLog.endpoint.authentication		Optional This item is the secret name for endpoint authentication. The end user needs to provide this secret to use upload feature. This secret is used for authentication of each protocol accordingly. Refer to " 1.2.16.1 Details of pgAuditLog.endpoint.authentication " for details. If this is not specified, a default secret <cluster-name>-pgauditlog-auth will be created.
spec.fep.pgAuditLog.endpoint.fileUploadParameter	file	Optional The file upload parameter defined by the web server
spec.fep.pgAuditLog.endpoint.azureBlobName		Only take effect when protocol is 'blob' Optional The blob name of pgaudit log file.

Field	Default	Details
		Default: [cluster name]-sts-[pod index]- pgauditlog.zip
spec.fep.pgAuditLog.endpoint.azureContainerName		Required with protocol is 'blob' This item is the container name of the Azure Storage account
spec.fep.pgAuditLog.config		Optional Default: none This item requires a ConfigMap with this name to exist in the same namespace of the FEPCluster. The ConfigMap will be used as pgAudit config file. The ConfigMap need to have a key 'pgaudit.conf'.
spec.fep.pgAuditLog.enable		Optional Default: false When set to 'true', the pgaudit extension is enabled automatically.
spec.fep.pgBadger.schedules.create		The 'create' schedule to create report and upload it to endpoint
spec.fep.pgBadger.schedules.cleanup		The 'cleanup' schedule to delete the report left in container
spec.fep.pgBadger.options.incremental	false	Default: false; When set to true: create incremental report in pgbadger
spec.fep.pgBadger.endpoint.authentication		a secret to contain authentication info to access endpoint support basic auth only
spec.fep.pgBadger.endpoint.customCertificateName		Client certificate reference in customCertificate CR
spec.fep.pgBadger.endpoint.fileUploadParameter	file	The file upload parameter defined by the web server
spec.fep.pgBadger.endpoint.insecure	false	equivalent to curl -insecure option
spec.fep.pgBadger.endpoint.url		Web server url to upload the report file
spec.ldap2pg.enable	true	Setting this to "true" will enable ldap2pg to execute periodically according to schedule defined. Setting this to "false" will remove the cronjob that execute the ldap2pg.
spec.ldap.caConfigMapRef		If LDAP server certificate is signed by a private CA, this key should point to a configmap that has the chain of certificates that ldap2pg and FEP should trust. Operator expects the key name in the configmap be ca.crt.
spec.ldap.ldapconfSecretRef		Name of secret that contains the ldap.conf When spec.ldap is defined but

Field	Default	Details
		<p>spec.ldap.ldapconfSecretRef is not defined, operator will create a default secret <fep-cluster>-ldapconf.</p> <p>Operator expects the key name in the secret be ldap.conf.</p>
spec.ldap2pg.ldap2pgyamlConfigMapRef		<p>Name of configmap that contains the ldap2pg.yml</p> <p>When spec.ldap2pg is defined but spec.ldap2pg.ldap2pgyamlConfigMapRef is not defined, Operator will create a default configmap <fep-cluster>-ldap2pgyaml.</p> <p>FEP Operator expects the key name in the configmap be ldap2pg.yml.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.ldap2pg.mode	check	<p>Whether ldap2pg should run in "check" mode or "real" mode. If not defined, ldap2pg will run in check mode.</p>
spec.ldap2pg.schedule		<p>Schedule to execute ldap2pg in a crontab format.</p> <p>If defined, Operator will create a cronjob using fep-cronjob container and remotely execute ldap2pg on fep-patroni container on a regular basis.</p> <p>If the schedule is not provided, Operator will set the schedule to 5/* * * *.</p>
spec.ldap2pg.skipPrivileges	false	<p>Options</p> <p>Configure synchronization of role attributes and permissions between ldap2pg and FEPCluster.</p> <p>Specify false if you want to synchronize role attributes with permissions, or true if you do not.</p> <p>If true, the behavior is the same as the --skip-privileges (-P) option of the ldap2pg command.</p>
spec.fep.feputils.image	<omitted>	<p>FEPUtills container image to use, quay.io/fujitsu/fujitsu-enterprise-postgres-18-utils:ubi9-18-1.0</p> <p>Optional.</p> <p>Omitted by default. In this case, the image URL is obtained from the operator container environment.</p> <p>If you specify an image, the operator will use that image to deploy the Utils container.</p> <p>When fepChildCrVal.storage.autoresize.enable is</p>

Field	Default	Details
		true, use this image to expand the pvc-auto-resize container of the fep-tuning Pod.
spec.fep.fepcronjob.image	<omitted>	FEPCronjob container image to use, quay.io/fujitsu/fujitsu-enterprise-postgres-cronjob:ubi9-18-1.0 Optional. Omitted by default. In this case, the image URL is obtained from the operator container environment. If you specify an image, the operator will use that image to deploy the Cronjob container.
spec.fep.autoTuning.prometheus.prometheusUrl		Required if fepChildCrVal.storage.autoresize.enable is true. Specifies the URL of the Prometheus for which you want to retrieve metrics.
spec.fep.autoTuning.prometheus.authSecret		Optional Basic authentication secret that provides the user name and encrypted password
spec.fep.autoTuning.prometheus.authSecret.secretName		Username and password, or the name of the secret that contains the token Changes made after the cluster is created will not take effect.
spec.fep.autoTuning.prometheus.authSecret.userKey		Key of the Secret given the user name
spec.fep.autoTuning.prometheus.authSecret.passwordKey		Key of the Secret with the password specified
spec.fep.autoTuning.prometheus.authSecret.tokenKey		Key of the Secret given the token
spec.fep.autoTuning.prometheus.authSecret.proxyKey		Key of the Secret specified by the proxy
spec.fep.autoTuning.prometheus.tls		
spec.fep.autoTuning.prometheus.tls.certificateName		Refers to the Kubernetes TLS secret that contains the certificate and private key. Prometheus uses this for certificate authentication. The certificate and private key itself are stored in the tls.crt and tls.key keys. Changes made after the cluster is created will not take effect.
spec.fep.autoTuning.prometheus.tls.caName		Refers to the Kubernetes ConfigMap containing the additional CA that the client uses to verify the server certificate. The CA is stored in the ca.crt key. Changes made after the cluster is created will not take effect.

Field	Default	Details
spec.fep.autoTuning.prometheus.maxRetry		Specifies the maximum number of retries when a query to Prometheus fails. If not specified, a maximum of 60 retries are attempted.
spec.fep.velero.enable	false	Optional Specifies whether the Velero DR feature is used (true) or not (false). This is omitted by default. In this case, the Velero DR feature is not available.
spec.fep.velero.labels		Optional If the Velero DR feature is used, specify the label to be given to the resource to be backed up by Velero. You can specify multiple labels. If omitted, backup-group: fep-backup is given.
spec.fep.velero.backup		Specifies the object storage information that stores the backup data and archive wal for FEPCluster to be built in a DR environment. Otherwise, FEPCluster built in a DR environment will fail to back up to object storage.
spec.fep.velero.backup.pgbackrestParams		" " When nothing is specified, and the parameter set in pgbackrest.conf is described from the line below. (Descriptions vary depending on the provider used) If you use the same object storage as in production, specify a different object storage path (repo*-path) than fepChildCrVal.backup.pgbackrestParams. If you specify the same object storage path, you will receive an event notification.
spec.fep.velero.backup.pgbackrestKeyParams		Optional " " is fixed, and the following line describes the parameters to be set in pgbackrest.conf. The value described by this parameter is masked with *****.
spec.fep.velero.backup.caName		Optional Set to use a CA file other than the system default. Specifies the name of the Configmap you created. If you use a different CA file than the production environment, give the CA file a different name and set it here. It must also be deployed in the DR environment.
spec.fep.velero.backup.repoKeySecretName		Optional Specifies the name of the Kubernetes Secret

Field	Default	Details
		<p>generated from the object storage key file. Specify in array format.</p> <p>If you use a different secret from the production environment, give the secret a different name and set it here. It must also be deployed in the DR environment.</p>
spec.fep.velero.restore.image.image		<p>Optional Image of the container to perform the restore It is omitted by default. In this case, the URL for image is obtained from the operator container environment.</p>
spec.fep.velero.restore.image.pullPolicy	IfNotPresent	<p>Specifies the pull policy for the image.</p> <ul style="list-style-type: none"> - Always - IfNotPresent
spec.fep.velero.restore.mcSpec.limit	cpu: 200m memory: 300Mi	Specifies the maximum number of resources to allocate to the restore execution container.
spec.fep.velero.restore.mcSpec.request	cpu: 100m memory: 200Mi	Specifies the lower number of resources to allocate to the restore execution container.
spec.fep.velero.restore.restoreTargetRepo	1	<p>Specifies the backup data used to restore FEPCluster to the DR environment and the object storage information where the archive wal is stored.</p> <p>This is the number of the repo in <code>fepChildCrVal.backup.pgbackrestParams</code>.</p>
spec.fep.fixedStats.scheduleN		<p>Schedule a locked statistics.</p> <p>Specify an integer for N.</p>
spec.fep.fixedStats.scheduleN.fixSchedule		<p>Time to start locked statistics.</p> <p>schedule in cron format</p> <p>The date and time are in UTC time.</p>
spec.fep.fixedStats.scheduleN.unfixSchedule		<p>Options</p> <p>Time to unpin locked statistics. Returns to regular statistics. If not specified, it is not cleared.</p> <p>schedule in cron format</p> <p>The date and time are in UTC time.</p>
spec.fep.fixedStats.scheduleN.targetDb		Specify the database for which you want to locked statistics.
spec.fep.fixedStats.scheduleN.fixedObject		<p>Options</p> <p>If the scope to be locked is smaller than the database, specify that object.</p> <p>Specify <code>schema.table.column</code>.</p> <p>The minimum range is the column and the maximum range is the schema.</p>

Field	Default	Details
spec.fep.fixedStats.endpoint.protocol		Specify the object storage vendor where statistics are stored. s3, blob, gcs can be specified. Also, if you want to directly import a file on the container, specify local.
spec.fep.fixedStats.endpoint.authentication		Specify this option if the protocol is s3, blob, gcs. Authentication for accessing object storage specify a Kubernetes Secret name that contains information.
spec.fep.fixedStats.scheduleN.url		Specify this option if the protocol is s3, gcs. Specify the URL from which to download the statistics binary file.
spec.fep.fixedStats.scheduleN.azureBlobName		Specify this if the protocol is a blob. Name of the blob containing the statistics binary file.
spec.fep.fixedStats.scheduleN.azureContainerName		Specify this if the protocol is a blob. This item is the container name of the Azure storage account.
spec.fep.fixedStats.scheduleN.file		Specify this if the protocol is a local. Specify the name of the file deployed on the fep-patropni container.
spec.fep.fixedStats.scheduleN.update	false	Set this setting to true if you want to download statistics to be locked from object storage.
spec.fep.fixedStats.image		The CronJob image to use. If not specified, the operator uses the latest version supported by the operator.
spec.fep.fixedStats.pullPolicy	IfNotPresent	
spec.fep.fixedStats.scheduleN.enable		Options You can specify whether scheduled statistics are to be locked or released. Executed if omitted or true, not if false.
spec.fep.freezingTuples.enable	false	Options When true is specified, enables periodic execution of freezing operations.
spec.fep.freezingTuples.scheduleN		Options Specifies the schedule for the freeze operation. You can specify multiple names in dictionary format. Specify an integer for N.
spec.fep.freezingTuples.scheduleN.start	0 1 * * *	Specifies the date and time for starting processing in cron format. If omitted, the default values are applied.
spec.fep.freezingTuples.scheduleN.executionTime	3600	Options Specified value: string Units: s, m, h,d

Field	Default	Details
		Specifies the duration of the processing. If no unit is specified, s is assumed. If omitted, the default values are applied.
spec.fep.backupStats.enable	false	You can set statistics to be backed up. If set to false, no backup is performed. If set to true, backup is performed. If spec.fep.backupStats.enable is not defined as false when FEPCluster is first built, it is set to true. If spec.fep.backupStats.schedule1 is not defined when FEPCluster is first built, a backup with default settings is defined in the FEPCluster custom resource.
spec.fep.backupStats.image		The CronJob image to use. If not specified, the operator uses the latest version supported by the operator.
spec.fep.backupStats.pullPolicy	IfNotPresent	
spec.fep.backupStats.scheduleN		Schedule a backup of the statistics. Specify an integer for N.
spec.fep.backupStats.scheduleN.backupSchedule		Time to start taking statistics backups. schedule in cron format The date and time are in UTC time.
spec.fep.backupStats.scheduleN.targetDb		Optional Specify the database to be backed up. If omitted, runs for all databases.
spec.fep.backupStats.scheduleN.fixedObject		Optional If the backup target is less than the database, specify the object. Specify schema.table.column. The minimum range is the column and the maximum range is the schema.
spec.fep.backupStats.scheduleN.comment		Optional Comments that can be defined when backing up statistics. If omitted, FepFixedStatsBackup:scheduleN is set. Do not use the following phrases in comments. FepFixedStats
spec.fep.backupStats.scheduleN.retention		Options At the same time as a scheduled backup, you can delete backups that are stored in the target database for a specified number of days or earlier.

Field	Default	Details
		Specify an integer. If omitted, no deletion is performed.
spec.fep.backupStats.scheduleN.enable		Options You can specify whether scheduled statistics are to be locked or released. Executed if omitted or true, not if false.
spec.fep.multiMasterReplication	-	Options Define the multi-master replication configuration.
spec.fep.hostName		If you created an SVC to accept connections from outside your deployed Kubernetes cluster, specify the hostname.
spec.fep.port		Specify the port to be used for connecting to the deployed Kubernetes cluster from outside.
spec.fep.multiMasterReplication.enable	false	Enable the construction of a multi-master replication configuration. Once enabled by setting this to true, the feature cannot be disabled.
spec.fep.multiMasterReplication.configMapName		Specify the ConfigMap name defining the FEPCluster or database for bidirectional replication.
spec.fep.multiMasterReplication.replicationHosts[]		Specify the information for the FEPCluster(s) for bidirectional replication in array format. You can specify up to 4 units.
spec.fep.multiMasterReplication.replicationHosts[].hostName		Specify the connectable hostname.
spec.fep.multiMasterReplication.replicationHosts[].port	27500	Options Specify the port of the host that can be connected to.
spec.fep.multiMasterReplication.replicationHosts[].pgAdminPassword		Specifies the password for the postgres user at the replication destination. After applying to the FEPCluster, this parameter is masked with *.
spec.fepChildCrVal.customCertificates		Optional An array of elements for defining a certificate. It consists of the following parameters: - username - certificateName - caName Used to setup SSL connection between publisher and subscriber clusters for logical replication.

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.customCertificates.userName		Optional This should be the username of the publisher database. When this parameter is specified, an empty folder is created under FEP Server Container- /tmp/custom_certs/<username>. The custom certificates are mounted in this empty folder. However, if this parameter is not specified, the section is ignored and folder is not created; hence the certificates are not mounted without it. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.customCertificates.certificateName	(created by user)	Optional This points to Kubernetes TLS secret that contains the custom certificate. The certificate itself is stored in the key tls.crt. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.customCertificates.caName	(created by user)	Optional This points to Kubernetes configmap that contains CA certificate to verify server. The CA is stored in the key ca.crt. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.backup		Optional This section is defined to enable fepbackup sidecar for cluster backup feature.
spec.fepChildCrVal.backup.image.image	<omitted>	FEP backup container image to be used quay.io/fujitsu/fujitsu-enterprise-postgres-18-backup:ubi9-18-1.0 It is optional. Image line is omitted by default. In such a case, it will pick up URL of image from operator container environment. If you specify the image, Operator will take that image to deploy backup container
spec.fepChildCrVal.backup.image.pullPolicy	IfNotPresent	
spec.fepChildCrVal.backup.mcSpec.limits	cpu: 0.2 memory: "300Mi"	
spec.fepChildCrVal.backup.mcSpec.requests	cpu: 0.1 memory: "200Mi"	
spec.fepChildCrVal.backup.type		Optional Specifiable value: local Apply the settings for taking a backup to the

Field	Default	Details
		<p>PV to the custom resource.</p> <p>Can only be set the first time the FEPCluster custom resource is applied.</p> <p>You cannot add or change settings after applying.</p>
spec.fepChildCrVal.backup.pgbackrestParams	<p>(If spec.fepChildCrVal.backup.type is local)</p> <p>[global]</p> <p>repo1-retention-full=7</p> <p>repo1-retention-full-type=time</p> <p>log-path=/database/log/backup</p>	<p>Specifies the object storage information that stores the backup data and archive wal.</p> <p>" " When nothing is specified, and the parameter set in pgbackrest.conf is described from the line below.</p> <p>The value described by this parameter is masked with *****. (Descriptions vary depending on the provider used)</p> <p>You cannot add or modify stanzas other than backupstanza.</p>
spec.fepChildCrVal.backup.pgbackrestKeyParams		<p>Optional</p> <p>" " is fixed, and the following line describes the parameters to be set in pgbackrest.conf. The value described by this parameter is masked with *****.</p>
spec.fepChildCrVal.backup.caName		<p>Optional</p> <p>Set to use a CA file other than the system default.</p> <p>Specifies the name of the Configmap you created.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.backup.repoKeySecretName		<p>Optional</p> <p>Specifies the name of the Kubernetes Secret generated from the object storage key file. Specify in array format.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.backup.schedule.num	<p>0</p> <p>(If spec.fepChildCrVal.backup.type is local)</p> <p>2</p>	<p>Number of schedules to set</p> <p>The maximum number of backup schedules is 5.</p>
spec.fepChildCrVal.backup.scheduleN.schedule	<p>(If spec.fepChildCrVal.backup.type is local)</p> <p>schedule1: schedule: "15 0 * * 0"</p> <p>schedule2: schedule: "15 0 * * 1-6"</p>	<p>Backup schedule in cron format.</p> <p>The date and time is UTC time.</p>
spec.fepChildCrVal.backup.scheduleN.type	(If spec.fepChildCrVal.backup.type is local)	full: Perform a full backup (Back up the contents of the database cluster).

Field	Default	Details
	<pre> schedule1: type: full schedule2: type: incr </pre>	incr – Perform an incremental backup (Backup only the database cluster files that were changed to the last backup migration).
spec.fepChildCrVal.backup.scheduleN.repo	1	Optional Gets a backup in the specified repository. The range is 1 to 256.
spec.fepChildCrVal.customPgAudit	<pre> [output] logger = 'auditlog' log_directory = '/database/log/audit' log_truncate_on_rotation = on log_filename = 'pgaudit-%a.log' log_rotation_age = 1d log_rotation_size = 0 [rule] </pre>	PgAudit file content
spec.fepChildCrVal.customPgHba	<pre> # define pg_hba custom rules here to be merged with default rules. # TYPE DATABASE USER ADDRESS METHOD </pre>	Entries to be inserted into pg_hba.conf
spec.fepChildCrVal.customPgParameters	<pre> # define custom postgresql.conf parameters below to override defaults. # Current values are as per default FEP deployment shared_preload_libraries='pgx_datamasking,pg_prewarm,pg_stat_statements,fsep_operator_security' session_preload_libraries='pg_prewarm' max_prepared_transactions = 100 max_worker_processes = 30 max_connections = 100 work_mem = 1MB maintenance_work_mem = 12MB shared_buffers = 128MB effective_cache_size = 384MB checkpoint_completion_target = 0.8 # tcp parameters tcp_keepalives_idle = 30 tcp_keepalives_interval = 10 tcp_keepalives_count = 3 # logging parameters in default fep installation </pre>	<p>Postgres configuration in postgresql.conf</p> <p>If the FEP server container utilizes images with a FEPBaseVersion less than 15, exclude fsep_operator_security from the configuration.</p> <p>If spec.fep.databaseSize is defined, the default value will be changed as shown below.</p> <p>shared_buffers = 30% of spec.fep.mcSpec.limits.memory</p> <p>work_mem = 30% of spec.fep.mcSpec.limits.memory / max_connections / 2</p> <p>effective_cache_size = 75% of spec.fep.mcSpec.limits.memory</p> <p>maintenance_work_mem = 10% of spec.fep.mcSpec.limits.memory / (1 + autovacuum_max_workers)</p>

Field	Default	Details
	<pre># if log volume is not defined, log_directory should be # changed to '/database/userdata/data/ log' log_directory = '/database/log' log_filename = 'logfile-%a.log' log_file_mode = 0600 log_truncate_on_rotation = on log_rotation_age = 1d log_rotation_size = 0 log_checkpoints = on log_line_prefix = '%e %t [%p]: [%l-1] user=%u,db=%d,app=%a,client=%h' log_lock_waits = on log_autovacuum_min_duration = 60s logging_collector = on pgaudit.config_file='/opt/app-root/src/ pgaudit-cfg/pgaudit.conf' log_replication_commands = on log_min_messages = WARNING log_destination = stderr # wal_archive parameters in default fep installation archive_mode = on archive_command = 'pgbackrest -- stanza=backupstanza --config=/ database/userdata/pgbackrest.conf archive-push %p' wal_level = replica max_wal_senders = 12 wal_keep_size = 1024 track_activities = on track_counts = on password_encryption = 'md5'</pre>	
spec.fep.vectorTransformation.enable	false	Setting to true activates the feature of model management in the database.
spec.fep.vectorTransformation.modelRepository.modelOwner.name	-	Set the model owner's name.
spec.fep.vectorTransformation.modelRepository.modelOwner.password	-	Set the model owner's password.
spec.fep.vectorTransformation.modelRepository.modelUser.name	-	Set the model user's name.

Field	Default	Details
spec.fep.vectorTransformation.modelRepository.modelUser.password	-	Set the model user's password.
spec.fep.vectorTransformation.modelRepository.modelLoader.name	-	Set the load user's name.
spec.fep.vectorTransformation.modelRepository.modelLoader.password	-	Set the load user's password.
spec.fep.vectorTransformation.inferenceServer	-	Parameters related to the inference server.
spec.fep.vectorTransformation.inferenceServer.image	-	Required when spec.fep.vectorTransformation.enable is true Specify the name of the built inference server.
spec.fep.vectorTransformation.inferenceServer.imagePullsecret	-	Required when spec.fep.vectorTransformation.enable is true Specify the Pullsecret to access the repository where the built inference server is published.
spec.fep.vectorTransformation.inferenceServer.connectionTls.enable	false	Set to true when using mTLS.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.grpcCaName	-	Specifies the TLS secret used for gRPC connections.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.grpcCertificateName	-	Specify the Secret name containing the CA certificate used to verify the server certificate chain for gRPC connections.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.grpcPrivateKey	-	Specifies the Kubernetes secret containing the password for the private key used for gRPC connections.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.tritonGrpcCaName	-	Specifies the TLS secret used for gRPC connections configured on the Triton server.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.tritonGrpcCertificateName	-	Specify the Secret name containing the CA certificate used to verify the server certificate chain for gRPC connections configured on the Triton server.
spec.fep.vectorTransformation.inferenceServer.connectionTls.certificate.tritonGrpcPrivateKey	-	Specify the secret name containing the CA certificate used to verify the server certificate chain for the gRPC connection configured on the Triton server.
spec.fep.vectorTransformation.inferenceServer.mcSpec.limits	cpu:500m memory:1Gi	Specifies the resource limit for the inference server.
spec.fep.vectorTransformation.inferenceServer.mcSpec.limits.requests	cpu:200m memory:512Mi	Specifies the minimum resources required by the inference server.
spec.fep.vectorTransformation.inferenceServerPorts.grpcPort	-	Required when spec.fep.vectorTransformation.enable is true.

Field	Default	Details
		Specifies the port number for gRPC connections.
spec.fep.vectorTransformation.inferenceServerPorts.metricsPort	-	Required when spec.fep.vectorTransformation.enable is true. Specifies the port number for acquiring metrics.
spec.fepChildCrVal.storage.dataVol		Mandatory volume
spec.fepChildCrVal.storage.dataVol.size	2Gi (**)	Size of data volume. Data volume must be specified You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.
spec.fepChildCrVal.storage.dataVol.storageClass	<omitted> (*)	StorageClass for data volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.dataVol.accessModes	<omitted> (*)	accessModes for data volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce] Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.walVol		Mandatory volume
spec.fepChildCrVal.storage.walVol.size	1200Mi (**) (If spec.fepChildCrVal.storage.dataSize is defined) 5Gi	Size of WAL volume. WAL volume must be specified You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.
spec.fepChildCrVal.storage.walVol.storageClass	<omitted> (*)	StorageClass for WAL volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.walVol.accessModes	<omitted> (*)	accessModes for WAL volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce]

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.tablespaceVol		Optional volume
spec.fepChildCrVal.storage.tablespaceVol.size	512Mi (**) (If spec.fepChildCrVal.storage.dataSize is defined) The value specified in spec.fepChildCrVal.storage.dataSize.	Size of tablespace volume. This volume is optional and can be omitted You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.
spec.fepChildCrVal.storage.tablespaceVol.storageClass	<omitted> (*)	StorageClass for tablespace volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.tablespaceVol.accessModes	<omitted> (*)	accessModes for tablespace volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce] Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.archiveWalVol		Mandatory if backup section is defined. Optional otherwise
spec.fepChildCrVal.storage.archiveWalVol.size	1Gi (**) (If spec.fepChildCrVal.storage.dataSize is defined and spec.fepChildCrVal.backup.type is local) (spec.fepChildCrVal.storage.dataSize/10)*14	Size of archivewal volume. This volume is optional and can be omitted You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.
spec.fepChildCrVal.storage.archiveWalVol.storageClass	<omitted> (*)	StorageClass for Archived WAL volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster When the number of instance is more than 1 and backup is not done on S3, both archivewalVol and backupVol must be hosted on Shared storage such as NFS with respective storageClass

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.archiveWalVol.accessModes	<omitted> (*)	accessModes for Archived WAL volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce] When the number of instance is more than 1 and backup is not done on S3, both archivalVol and backupVol must be hosted on Shared storage such as NFS with accessMode set to [ReadWriteMany] Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.logVol		Optional volume
spec.fepChildCrVal.storage.logVol.size	1Gi (**) (If spec.fepChildCrVal.storage.dataSize is defined) 5Gi	Size of log volume. This volume is optional and can be omitted You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.
spec.fepChildCrVal.storage.logVol.storageClass	<omitted> (*)	StorageClass for log volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.logVol.accessModes	<omitted> (*)	accessModes for log volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce] Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.backupVol		Mandatory if backup section is defined. Optional otherwise
spec.fepChildCrVal.storage.backupVol.size	2Gi (**) (If spec.fepChildCrVal.storage.dataSize is defined and spec.fepChildCrVal.backup.type is local) spec.fepChildCrVal.storage.dataSize*14	Size of backup volume. This volume is optional and can be omitted You can only expand the size of a cluster after it has been created if the StorageClass supports volume expansion. You cannot reduce the size.

Field	Default	Details
spec.fepChildCrVal.storage.backupVol.storageClass	<omitted> (*)	StorageClass for backup volume: When this line is omitted, the PV created will use default storage class in the Kubernetes cluster When the number of instance is more than 1 and backup is not done on S3, both archivalVol and backupVol must be hosted on Shared storage such as NFS with respective storageClass Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.backupVol.accessModes	<omitted> (*)	accessModes for backup volume: Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce] When the number of instance is more than 1 and backup is not done on S3, both archivalVol and backupVol must be hosted on Shared storage such as NFS with accessMode set to [ReadWriteMany] Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.dataSize		Specify the amount of data at the data storage destination. The operator defines the size of dataVol, walVol, logVol, tablespaceVol, archivalVol, and backupVol based on the specified value. If you specify individual volumes, specify the size of each volume definition. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.accessModes		Specify the accessModes for each volume if you want to specify them in a batch. If you want to set them individually, specify the accessModes for each volume definition. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.storageClass		Specify the storageClass for each volume if you want to specify them in a batch. If you want to set them individually, specify the storageClass for each volume definition. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.storage.autoresize		

Field	Default	Details
spec.fepChildCrVal.storage.autoresize.enable	false	Optional Specified value: boolean true to enable auto-extension for PVCs.
spec.fepChildCrVal.storage.autoresize.mcSpec.limits	cpu: 50m memory: 60Mi	Optional Specifies the resource limit that can be allocated to pvc-auto-resize container.
spec.fepChildCrVal.storage.autoresize.mcSpec.requests	cpu: 10m memory: 5Mi	Optional Specifies the resources to assign that can be allocated to pvc-auto-resize container.
spec.fepChildCrVal.storage.autoresize.interval	30	Optional Units: s Specifies the interval between metric checks. If 0 or less is specified, the PVC is not extended.
spec.fepChildCrVal.storage.autoresize.threshold	80	Optional Specified value: integer Unit:% Specifies the storage utilization threshold. Extends the PVC when this value is exceeded. When 0 is specified, storage utilization is not checked. The xxxVol.threshold applies to all storage that is not defined.
spec.fepChildCrVal.storage.autoresize.increaseType	percent	Optional Specified value: percent, size Specifies how the PVC extension is estimated when the threshold is exceeded. When percent is specified Expands the PVC by the specified percentage of its original capacity. If size is specified Extends the PVC by the specified amount (Gi). Applies to all storage where xxxVol.increaseType is not defined.
spec.fepChildCrVal.storage.autoresize.increase	25	Optional Specified value: integer Units:% or Gi Specifies the extension amount for the PVC.

Field	Default	Details
		<p>The units depend on the value specified for increaseType.</p> <p>If a value less than or equal to 0 is specified, no extension is performed.</p> <p>This applies to all storage where xxxVol.increase is not defined.</p>
spec.fepChildCrVal.storage.autoresize.storageLimit		<p>Optional</p> <p>Specified value: integer</p> <p>Units: Gi</p> <p>Specifies the maximum value by which the PVC can be extended.</p> <p>If not specified, the extension is unrestricted. If you do not specify this value, we recommend that you verify that the storage class being used has a namespace quota.</p> <p>Do not extend the PVC when less than or equal to disk space is specified.</p> <p>Applies to all storage where xxxVol.storageLimit is not defined.</p>
spec.fepChildCrVal.storage.xxxVol		xxx is the contents of data, wal, log, tablespace, archival, backup
spec.fepChildCrVal.storage.xxxVol.threshold		<p>Optional</p> <p>Specified value: integer</p> <p>Unit:%</p> <p>Specifies the storage utilization threshold.</p> <p>Extends the PVC when this value is exceeded.</p> <p>When 0 is specified, storage utilization is not checked.</p> <p>If not specified, it follows the value specified in autoresize.threshold.</p>
spec.fepChildCrVal.storage.xxxVol.increaseType		<p>Optional</p> <p>Specified value: percent, size</p> <p>Specifies how the PVC extension is estimated when the threshold is exceeded.</p> <p>When percent is specified</p> <p>Expands the PVC by the specified percentage of its original capacity.</p> <p>If size is specified</p> <p>Extends the PVC by the specified amount (Gi).</p> <p>If not specified, the value specified by autoresize.increaseType.</p>

Field	Default	Details
spec.fepChildCrVal.storage.xxxVol.increase		Optional Specified value: integer Units:% or Gi Specifies the extension amount for the PVC. The units depend on the value specified for increaseType. If not specified, the value specified by autoresize.increase.
spec.fepChildCrVal.storage.xxxVol.storageLimit		Optional Specified value: integer Units: Gi Specifies the maximum capacity by which the PVC can be extended. Do not expand if the specification is less than or equal to the disk capacity. If not specified, it follows the value specified by autoresize.storageLimit.
spec.fepChildCrVal.storage.inferenc eVol.size	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the size of the model to mount.
spec.fepChildCrVal.storage.inferenc eVol.storageClass	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the name of the storage class to mount.
spec.fepChildCrVal.storage.inferenc eVol.accessMode	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the access mode for the storage to mount.
spec.fepChildCrVal.storage.modelR epositoryVol.size	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the size of the model to mount.
spec.fepChildCrVal.storage. modelRepositoryVol.storageClass	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the name of the storage class to mount.
spec.fepChildCrVal.storage. modelRepositoryVol.accessMode	-	Required when spec.fep.vectorTransformation.enable.enab le is true Specifies the access mode for the storage to mount.

Field	Default	Details
spec.fepChildCrVal.sysUsers.pgAdminPassword	<omitted>	<p>Password for user "postgres"</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$ % ^ & * () - = < > , . ? ; : / +)</p> <p>If this parameter is omitted, the Operator automatically generates a password.</p> <p>If the FEP server container uses an image with a FEPBaseVersion less than 15, be sure to specify this parameter.</p>
spec.fepChildCrVal.sysUsers.pgdb	mydb (*)	<p>Database to be created during provisioning</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_)</p> <p>However, you cannot start with a number.</p> <p>Upper case letters are treated as lower case letters.</p> <p>Maximum string length</p> <p>63 characters</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.sysUsers.pguser	mydbuser (*)	<p>Database user to be created during provisioning</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_)</p> <p>However, you cannot start with a number.</p> <p>Upper case letters are treated as lower case letters.</p> <p>Maximum string length</p> <p>63 characters</p> <p>This database user is the owner of the database defined in "spec.fepChildCrVal.sysUsers.pgdb" and has the role of database administrator.</p> <p>This user has the following privileges: NOSUPERUSER, NOREPLICATION, NOBYPASSRLS, CREATEDB, INHERIT, LOGIN, CREATEROLE</p> <p>(NOCREATEROLE when spec.fepChildCrVal.sysUsers.pgSecurityUser is defined)</p> <p>They also belong to the following roles: pg_monitor, pg_signal_backend</p>

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgpassword	mydbpassword	Password for database user pguser Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$ % ^ & * () - = < > . ? ; : /+)
spec.fepChildCrVal.sysUsers.pgrepuser	repluser (*)	Database user for replication Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_) However, you cannot start with a number. Maximum string length 63 characters Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgreppassword	repluserpwd	Alphanumeric characters
spec.fepChildCrVal.sysUsers.tdepassphrase	tde-passphrase	TDE keystore passphrase
spec.fepChildCrVal.sysUsers.pgRewindUser	rewind_user	Database user for Rewind Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_) However, you cannot start with a number. Maximum string length 63 characters Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgRewindPassword	rewind_password	Password for database user rewinduser Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$ % ^ & * () - = < > . ? ; : /+)
spec.fepChildCrVal.sysUsers.pgMetricsUser		Optional user for FEPEXporter connection. Can be defined afterwards You can define or delete them later. Changes to predefined usernames will not be applied. Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_) However, you cannot start with a number.

Field	Default	Details
		<p>Upper case letters are treated as lower case letters.</p> <p>Maximum string length</p> <p>63 characters</p>
spec.fepChildCrVal.sysUsers.pgMetricsPassword		<p>Optional</p> <p>Password for metrics user. Can be defined afterwards</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$% ^ & * () - = < > , . ? ; : /+)</p>
spec.fepChildCrVal.sysUsers.pgSecurityUser		<p>Options</p> <p>Username of the security administrator user. Can be defined later.</p> <p>This parameter is optional, but cannot be changed or deleted after it has been defined.</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), and underscores (_)</p> <p>However, you cannot start with a number.</p> <p>Upper case letters are treated as lower case letters.</p> <p>Maximum string length</p> <p>63 characters</p>
spec.fepChildCrVal.sysUsers.pgSecurityPassword		<p>Options</p> <p>Defines the password for the sensitive administrator user.</p> <p>This parameter is optional but required when "pgSecurityUser" is defined.</p> <p>Available character types</p> <p>Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$% ^ & * () - = < > , . ? ; : /+)</p>
spec.fepChildCrVal.sysUsers.passwordValid		<p>Options</p> <p>Manage password expiration for database users.</p> <p>Sets the expiration date for database user passwords defined in the FEPCluster custom resource below.</p> <ul style="list-style-type: none"> - pgpassword, pgSecurityPassword <p>In addition, if shared_preload_libraries in customPgParams is set to "fsep_operator_security" and the "CREATE ROLE" or "ALTER ROLE" command is used to update the password of a database</p>

Field	Default	Details
		<p>user with login privileges and the expiration time is not defined or is longer than the specified expiration time, the operation will fail.</p> <p>Updates the password expiration date for database users with login privileges that have not expired when the specified expiration date is updated.</p>
spec.fepChildCrVal.sysUsers.passwordValid.days		<p>Options</p> <p>Specifies the number of days the database role is valid.</p> <p>Specify an integer value greater than or equal to 0.</p> <p>If any other value is entered, it is treated as 0 (no expiration date is set).</p> <p>The 'days' option is not available when using the Cloud-based Secret Management feature.</p> <p>When you take advantage of the Cloud-based Secret Management feature, the database user password expiration can be managed by a rotation policy provided by an external secret store service.</p>
spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName		<p>This points to Kubernetes TLS secret that contains the certificate of Postgres user "postgres". Patroni will use this for certificate authentication. The certificate itself is stored in the key tls.crt. This field is optional.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.sysUsers.pgAdminTls.caName		<p>This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt. This field is optional.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.sysUsers.pgAdminTls.sslMode	prefer	<p>Specify the type of TLS negotiation with the server.</p> <ul style="list-style-type: none"> - disable - allow - prefer - require - verify-ca - verify-full <p>Changes made after the cluster is created will not take effect.</p>

Field	Default	Details
spec.fepChildCrVal.sysUsers.pgrepr UserTls.certificateName		<p>This points to Kubernetes TLS secret that contains the certificate of Postgres user "repluser". Patroni will use this for certificate authentication. The certificate itself is stored in the key tls.crt. This field is optional.</p> <p>In the current implementation, changes to this field name are not reflected.</p>
spec.fepChildCrVal.sysUsers.pgrepr UserTls.caName		<p>This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt. This field is optional.</p> <p>In the current implementation, changes to this field name are not reflected.</p>
spec.fepChildCrVal.sysUsers.pgrepr UserTls.sslMode	prefer	<p>Specify the type of TLS negotiation with the server.</p> <ul style="list-style-type: none"> - disable - allow - prefer - require - verify-ca - verify-full
spec.fepChildCrVal.sysUsers.pgRe windUserTls.certificateName		<p>This points to Kubernetes TLS secret that contains the certificate of Postgres user "rewinduser". Patroni will use this for certificate authentication. The certificate itself is stored in the key tls.crt. This field is optional.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.sysUsers.pgRe windUserTls.caName		<p>This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt. This field is optional.</p> <p>Changes made after the cluster is created will not take effect.</p>
spec.fepChildCrVal.sysUsers.pgRe windUserTls.sslMode	prefer	<p>Specify the type of TLS negotiation with the server.</p> <ul style="list-style-type: none"> - disable - allow - prefer - require - verify-ca - verify-full

Field	Default	Details
		Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgMetricsUserTls.certificateName		Optional This points to Kubernetes TLS secret that contains the certificate of Postgres user defined by pgMetricsUser. FEPEXporter will use this for certificate authentication. The certificate itself is stored in the key tls.crt. You can define it later. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgMetricsUserTls.caName		Optional This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt. You can define it later. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.pgMetricsUserTls.sslMode	prefer	Optional Specify the type of TLS negotiation when FEPEXporter connects to FEP server. <ul style="list-style-type: none"> - disable - allow - prefer - require - verify-ca - verify-full You can define it later. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.sysUsers.vectorizerPassword		Optional Specifies the password for "vectorizerrole," which will be created as the database role used by the automatic vector converter to perform vector conversions in the background. Available character types Alphanumeric characters (A-Z, a-z), numbers (0-9), symbols (~! @ # \$ % ^ & * () - = < > , . ? ; : / +) If this parameter is omitted, the Operator automatically generates a password.
spec.fepChildCrVal.sysUsers.vectorizerTls.certificateName		This points to Kubernetes TLS secret that contains the certificate of Postgres user "vectorizerrole". Patroni will use this for

Field	Default	Details
		<p>certificate authentication. The certificate itself is stored in the key <code>tls.crt</code>. This field is optional.</p> <p>You can define it later.</p> <p>Changes made after the cluster is created will not take effect.</p>
<code>spec.fepChildCrVal.sysUsers.vectorizerTls.caName</code>		<p>This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key <code>ca.crt</code>. This field is optional.</p> <p>You can define it later.</p> <p>Changes made after the cluster is created will not take effect.</p>
<code>spec.fepChildCrVal.sysUsers.vectorizerTls.sslMode</code>	<code>prefer</code>	<p>Specify the type of TLS negotiation with the server.</p> <ul style="list-style-type: none"> - <code>disable</code> - <code>allow</code> - <code>prefer</code> - <code>require</code> - <code>verify-ca</code> - <code>verify-full</code> <p>You can define it later.</p> <p>Changes made after the cluster is created will not take effect.</p>
<code>spec.fepChildCrVal.sysTde</code>	(*)	<p>Optional</p> <p>If the user selects a file-based TDE, you do not need to define it.</p> <p>Required when implementing TDE with a key management system (KMS).</p>
<code>spec.fepChildCrVal.sysTde.tdeType</code>	(*)	<p>Optional</p> <p>The parameter itself is optional, but required when <code>spec.fepChildCrVal.sysTde</code> is defined.</p> <p>Specify <code>tdek</code>.</p>
<code>spec.fepChildCrVal.sysTde.tdek</code>		<p>Optional</p> <p>Defines the connection information to the KMS.</p> <p>Required when <code>tdek</code> is specified for <code>spec.fepChildCrVal.sysTde.tdeType</code>.</p>
<code>spec.fepChildCrVal.sysTde.tdek.targetKmsName</code>		<p>Specify one of the key management system names defined in <code>kmsDefinition[*].name</code> as the name of the key management system to use as the keystore.</p>
<code>spec.fepChildCrVal.sysTde.tdek.targetKeyId</code>		<p>Specifies the key ID (Identifier attribute in KMIP) attached to the encryption key in KMS.</p> <p>When you update this parameter, the</p>

Field	Default	Details
		Operator automatically updates the master key.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition		Specifies KMS connection information. Specify in array format. You can specify connection information for multiple KMS.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].name	(*)	The name given to the KMS (key management system name) specified in spec.fepChildCrVal.sysTde.tdek.targetKmsName. The KMS name must be a string of no more than 63 characters beginning with a-z, consisting of a-z, numbers (0-9), and underscores. Upper and lower case letters are the same.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].type	(*)	Specifies the type of KMS. You can specify either kmip, awskms, or azurekeyvault.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].address	(*)	Specifies the host name or IP address of the KMIP server.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].port	(*)	Specifies the port of KMIP server.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].authMethod[*].authMethod	(*)	Specifies the authentication method in KMIP server. Currently, the only possible value is cert.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].sslpassphrase		Optional Specifies the passphrase of the client certificate private key file when connecting to KMIP server. This can be omitted if no passphrase is set in the private key file.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].cert		Optional Specifies the name of the Secret/ConfigMap containing the certificate file, etc., when cert is specified as authMethod.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].cert.certificateName	(*)	Specifies the TLS Secret name that contains the client certificate and private key for TLS communication with KMIP server.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].cert.caName	(*)	Specifies the ConfigMap name that contains the file name of the SSL Certificate Authority certificate. Used to verify the server certificate of the connection destination.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].profile		Specify a profile that uses AWS KMS. For more information about profile, see the official AWS documentation.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].awsKmsCredentials		Specify a Secret that contains credentials (access key id and secret access key) to AWS KMS.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].awsKmsConfig		Specify a ConfigMap that contains configuration information for the AWS KMS CLI.

Field	Default	Details
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].appid		Enter the application ID when using Azure Key Vault. You can get this when you create a service principal.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].tenantid		Specify tenantid when using Azure Key Vault. You can get this when you create a service principal.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].encAlgorithm		Specifies when using Azure Key Vault. See the appendix for the algorithms you can select, refer to "Available Algorithms" in the User's Guide.
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].azureKeyVaultClientPassphrase		Used to authenticate to Azure Key Vault. Specifies the secret that contains the client Secret (password).
spec.fepChildCrVal.sysTde.tdek.kmsDefinition[*].azureKeyVaultClientCert		Used to authenticate to Azure Key Vault. Specifies the Secret that contains the client certificate.
spec.fepChildCrVal.systemCertificates.key		Use spec.fep.postgres.tls specification instead.
spec.fepChildCrVal.systemCertificates.crt		Use spec.fep.postgres.tls specification instead.
spec.fepChildCrVal.systemCertificates.cacrt		Use spec.fep.postgres.tls specification instead.
spec.fepChildCrVal.autoscale.scaleout.policy	off	Specifies whether to use the automatic scale out feature and the metric to base on. Specify one of the following: <ul style="list-style-type: none"> - cpu_utilization (if based on CPU utilization) - connection_number (if based on number of connections) - off (without automatic scale out) If omitted, off is assumed.
spec.fepChildCrVal.autoscale.scaleout.threshold	40	Specifies an integer as the threshold for performing scale out. <ul style="list-style-type: none"> - When cpu_utilization is specified for policy Specifies the average CPU utilization as a percentage for the threshold. If this option is omitted, 40 (40%) is assumed. - When connection_number is specified for policy Specifies the average value of the number of connections as a threshold. If you omit this option, 40 is assumed.
spec.fepChildCrVal.autoscale.scaleout.metricName	pg_capacity_connection_average	Specify this parameter if policy is connection_number. Ignored if policy is cpu_utilization. The custom metrics server must publish the average number of connections in the FEP cluster under this name.

Field	Default	Details
		If omitted, pg_capacity_connection_average is assumed.
spec.fepChildCrVal.autoscale.scaleout.stabilizationWindowSeconds	0	This parameter controls the stability of scaling (variation in the number of replicas). Scale out is not performed unless the metric exceeds the threshold for more than the number of seconds specified for this parameter. If omitted, 0 is assumed.
spec.fepChildCrVal.autoscale.limits.maxReplicas	2	Maximum number of replicas (0 to 15) (Value out of range) Do not perform auto scale out
spec.fepChildCrVal.restore		Optional Defines to restore specified backup data stored in object storage.
spec.fepChildCrVal.restore.pgbackrestParams		Optional " " is fixed, and the following line describes the parameters to be set in pgbackrest.conf. Specifies the object storage where the backup data is stored. If you need to use a root certificate other than the default, specify the following: repo1-storage-ca-path =/pgbackrest/storage-certs/filename The CA file is registered in ConfigMap and the ConfigMap name is listed in spec.fepChildCrVal.restore.caName.
spec.fepChildCrVal.restore.pgbackrestKeyParams		Optional " " is fixed, and the following line describes the parameters to be set in pgbackrest.conf. The value described by this parameter is masked with *****. Specify the parameter you want to mask, such as a password.
spec.fepChildCrVal.restore.caName		Optional Set to use a CA file other than the system default. Specifies the name of the ConfigMap created, in list format. The ConfigMap specified is mounted in /pgbackrest/storage-certs.
spec.fepChildCrVal.restore.repoKeySecretName		Optional Specifies the name of the Kubernetes Secret generated from the object storage key file. Specify in array format. The specified Secret will be mounted in /pgbackrest/storage-key.

Field	Default	Details
spec.fepChildCrVal.restore.mcSpec.limits	cpu: 200m memory: 300Mi	Optional CPU and memory allocated to the container performing the restore
spec.fepChildCrVal.restore.mcSpec.requests	cpu: 100m memory: 200Mi	Optional CPU and memory allocated to the container performing the restore
spec.fepChildCrVal.restore.restoretype	latest	Optional Select the type of restore (latest or PITR).
spec.fepChildCrVal.restore.restoredate		Optional Specifies the date to restore when spec.fepChildCrVal.restore.restoretype is "PITR".
spec.fepChildCrVal.restore.restoretime		Optional Specifies the time to restore when spec.fepChildCrVal.restore.restoretype is "PITR".
spec.fepChildCrVal.restore.image		Optional Image of the container to perform the restore It is omitted by default. In this case, the URL for image is obtained from the operator container environment.
spec.fepChildCrVal.restore.imagePullPolicy	IfNotPresent	Optional
spec.fepChildCrVal.upgrade		Optional When this field is defined, a major version upgrade is performed. However, if spec.fepChildCrVal.restore is defined, the FEPCluster build stops. The values in this section are referenced only when creating an upgrade request.
spec.fepChildCrVal.upgrade.sourceCluster		Specifies the FEPClusterCR name from which to migrate data. Required if spec.fepChildCrVal.upgrade is defined.
spec.fepChildCrVal.upgrade.mcSpec.limits	cpu: 200m memory: 300Mi	Optional Specifies the maximum number of resources to allocate to the upgrade execution container.
spec.fepChildCrVal.upgrade.mcSpec.requests	cpu: 100m memory: 200Mi	Optional Specifies the lower limit of resources allocated to the upgrade execution container.
spec.fepChildCrVal.upgrade.image		Optional By default, the URL of image is obtained from the operator container environment.

Field	Default	Details
spec.fepChildCrVal.upgrade.imagePullPolicy	IfNotPresent	Optional Specifies the pull policy for the container image. <ul style="list-style-type: none"> - Always - IfNotPresent - Never
spec.fepChildCrVal.upgrade.source.pgAdminTls.certificateName		Optional If you do not define spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName for the data source, it points to the Kubernetes TLS secret that contains the certificate for the Postgres user "postgres" in the data source. If the data source FEP has set the authentication method for the upgrade execution container to "cert", then the upgrade execution container uses the certificate defined as secret.
spec.fepChildCrVal.upgrade.destination.pgAdminTls.certificateName		Optional If you have not defined the spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName of the newly created FEPCluster, it points to the Kubernetes TLS secret that contains the certificate of the Postgres user "postgres" in the data source. If you create a new FEP with the "cert" authentication method for the upgrade execution container, the upgrade execution container uses the certificate defined as secret.
spec.fepChildCrVal.upgrade.storage		Optional Defines the storage for storing dump files. The values in this section are referenced only when creating an upgrade request.
spec.fepChildCrVal.upgrade.storage.storageClass		Optional If omitted, the default storage class for your environment is used.
spec.fepChildCrVal.upgrade.storage.size	2Gi	Optional Specifies the size of the storage to store the dump file.
spec.fepChildCrVal.upgrade.storage.accessModes	ReadWriteOnce	Optional accessModes for store the dump file Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce]

Field	Default	Details
spec.fep.remoteLogging.image		Optional Fluentbit image to be used. If not specified, Operator will use the latest version that is supported by the Operator.
spec.fep.remoteLogging.pullPolicy	IfNotPresent	Optional Changes made after the cluster is created will not take effect.
spec.fep.remoteLogging.fluentdName		Optional The name of the FEPLogging CR to which logs are transferred. Specify this option to use the FEPLogging function to transfer logs.
spec.fep.remoteLogging.tls.certificateName		Optional Kubernetes secret name which holds fluentbit certificate. FEPLogging will use this for certificate authentication. The certificate itself is stored in the key tls.crt. Changes made after the cluster is created will not take effect.
spec.fep.remoteLogging.tls.caName		Optional Kubernetes configmap which holds cacert of Fluentd to which fluentbit will use to perform MTLs. Changes made after the cluster is created will not take effect.
spec.fep.remoteLogging.mcSpec.limits.cpu	50m	Optional CPU allocation limit for fluentbit.
spec.fep.remoteLogging.mcSpec.limits.memory	60Mi	Optional Memory allocation limit for fluentbit.
spec.fep.remoteLogging.mcSpec.requests.cpu	10m	Optional CPU allocation request for fluentbit.
spec.fep.remoteLogging.mcSpec.requests.memory	5Mi	Optional Memory allocation request for fluentbit.
spec.fep.remoteLogging.fluentbitConfigSecretRef		Optional Specifies the name of the secret containing fluent-bit.yaml when using the log transfer feature with remote logging. If fluentbitConfigSecretRef is not defined, or if fluentbitConfigSecretRef is defined but the referenced secret does not exist, the operator creates a default Secret <fep-cluster>-fluent-bit-conf and updates this parameter with <fep-cluster>-fluent-bit-conf.

Field	Default	Details
		If the referenced secret exists, the named secret is mounted to fep-logging-fluent-bit under/fluent-bit/etc.
spec.fep.remoteLogging.awsCredentialSecretRef		Optional Specify the name of the Secret that contains authentication information to the AWS service. Authentication information stores configuration files and authentication information files. The configuration file must be named "config" and the credentials file must be named "credentials". If the referenced secret exists, the named secret is mounted to fep-logging-fluent-bit under/fluent-bit/aws.
spec.fepChildCrVal.secretStore.csi.providerName		Optional Provider name. Can be one of the following: Azure/AWS/GCP/Vault. Must be "Azure" or "azure" in case of azure provider
spec.fepChildCrVal.secretStore.csi.azureProvider.credentials		Optional Secret created by User that contains the required credentials to connect to Azure keyvault Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.secretStore.csi.azureProvider.tenantid		Optional Tenant id where keyvault is created
spec.fepChildCrVal.secretStore.csi.azureProvider.keyvaultname		Optional Name of the keyvault where secrets are stored
spec.fepChildCrVal.secretStore.csi.azureProvider.fepSecrets		Optional List of the parameters and their corresponding secret created in the Vault Eg: <fep parameter name>: <secret in keyvault>
spec.fepChildCrVal.secretStore.csi.azureProvider.fepCustomCert		Optional Only defined when logical replication feature is enabled
spec.fepChildCrVal.secretStore.csi.awsProvider.region		Optional AWS Region where EKS cluster is created
spec.fepChildCrVal.secretStore.csi.awsProvider.roleName		Optional Role Name for the IAM trust policy

Field	Default	Details
spec.fepChildCrVal.secretStore.csi.awsProvider.fepSecrets		Optional List of the parameters and their corresponding secret created in the Vault Eg: <fep parameter name>: <secret in keyvault>
spec.fepChildCrVal.secretStore.csi.awsProvider.fepCustomCert		Optional Only defined when logical replication feature is enabled
spec.fepChildCrVal.secretStore.csi.gcpProvider.credentials		Optional Secret created by User that contains the required credentials to connect to GCP Secret Manager Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.secretStore.csi.gcpProvider.fepSecrets		Optional List of the parameters and their corresponding secret created in the Vault Eg: <fep parameter name>: <secret in keyvault>
spec.fepChildCrVal.secretStore.csi.gcpProvider.fepCustomCert		Optional Only defined when logical replication feature is enabled
spec.fepChildCrVal.secretStore		Optional Not required to be defined if user opts to store all secrets in kubernetes environment
spec.fepChildCrVal.secretStore.csi.vaultProvider.roleName		Optional roleName created by user in the Vault
spec.fepChildCrVal.secretStore.csi.vaultProvider.vaultAddress		Optional Address of the vault that is accessible from the FEP environment
spec.fepChildCrVal.secretStore.csi.vaultProvider.fepSecrets		Optional List of the parameters and their corresponding secret created in the Vault Eg: <fep parameter name> : </path/to/secret/secretName> in vault>
spec.fepChildCrVal.secretStore.csi.vaultProvider.fepCustomCert		Optional Only defined when logical replication feature is enabled
spec.fep.measurement.recallForVector.enable	false	When specified as true, enables vector database recall measurement.
spec.fep.measurement.recallForVector.schedule	15 0 1 * *	Optional The date and time to start the measurement, in Cron format.

Field	Default	Details
spec.fep.measurement.recallForVect or.parallelJobs	5	Optional Specifies the number of jobs to be executed concurrently. Increasing the number of parallelisms reduces the measurement time, but increases the system load on the database container. Adjust this parameter based on system load and measurement completion time.
spec.fep.measurement.recallForVect or.maxDuration	0	Optional Units: s, m, h, d If you do not specify a unit, it is s (seconds). Specifies the end time of the measurement. If the measurement is not completed during the end period, the measurement is terminated. If 0 is specified, it does not stop until all measurements are complete.
spec.fep.measurement.recallForVect or.sampleSize	100	Optional Specifies the number of samples to use for the recall measurement. The larger the number of samples, the more accurate the recall is, but the more time it takes to measure. Adjust this parameter based on estimation error and calculation time.
spec.fep.measurement.recallForVect or.topK	5	Optional SELECT the top K items for which the recall is to be calculated. We recommend that you use the same value as LIMIT when performing a search on a vector database.
spec.fep.measurement.recallForVect or.alertThreshold	0	Optional If the recall falls below this threshold, an alert is issued to the AlertManager. The value can be between 0 and 1. If 0 is specified, no alert is created.
spec.fep.measurement.recallForVect or.targets[]		Specifies what the recall is measured for. You can specify multiple values in array format. At least one database object must be specified when enabling vector database recall measurement.
spec.fep.measurement.recallForVect or.targets[].database		The name of the database to measure recall.
spec.fep.measurement.recallForVect or.targets[].tableConfigs[]		Specifies the table information to retrieve.

Field	Default	Details
		You can specify multiple values in array format.
spec.fep.measurement.recallForVector.targets[].tableConfigs[].schemaObject		For objects whose recall is to be measured, specify the schema, table, and column separated by dots(.).
spec.fep.measurement.recallForVector.targets[].tableConfigs[].distanceMetric	cosine	Optional Specifies the distance calculation method (cosine, inner_product, l2). Choose the same distance calculation that the embedded model uses during training.
spec.globalEnvSec		Specifies the name of the Kubernetes secret that contains variables common to all containers. The defined key-value pairs are added to all containers running on FEPCluster. Changes made after the cluster is created will not take effect.
spec.fep.fepEnvSec		Specifies the name of the Kubernetes secret that contains key/value pairs specific to the fep-patroni container. Changes made after the cluster is created will not take effect.
spec.fep.feputils.fepUtilsEnvSec		Specifies the name of the Kubernetes secret that contains key-value pairs specific to feputils sidecar. Changes made after the cluster is created will not take effect.
spec.fep.remoteLogging.fluentBitEnvSec		Specifies the name of the Kubernetes secret that contains key-value pairs specific to the fep-logging-fluent-bit sidecar. Changes made after the cluster is created will not take effect.
spec.fep.monitoring.fepExporter.fepExporterEnvSec		Specifies the name of the Kubernetes secret that contains key-value pairs specific to the prometheus-fep-exporter sidecar. Changes made after the cluster is created will not take effect.
spec.fepChildCrVal.backup.fepBackupEnvSec		Specifies the name of the Kubernetes secret that contains key-value pairs specific to fepbackup sidecar. Changes made after the cluster is created will not take effect.

Note

- (*) - These parameters can be specified only at creation time and should not be changed. Any change to these parameters will be ignored and will not have any effect on FEP cluster functioning.

- (**)- The storage volumes size can be increased provided underlying storage supports the operation. Optional volumes can be specified only at initial FEP cluster creation. If an optional volume is added later, operator will ignore it and no action will be taken.
- User should do or remove unsupported CR changes manually.
- spec.fep.postgres.tls CR specification should be used instead of spec.fepChildCrVal.systemCertificates. The lateral spec can still be used, however spec.fep.postgres.tls gives better flexibility to control MTLs access of the cluster.
- Either spec.fep.postgres.tls specification (old specification) or spec.fepChildCrVal.systemCertificates should be used. They should not be used interchangeable.
- Server certificate specified under spec.fep.postgres.tls can be rotated by changing the secret and executing reload (e.g. using FEPACTION); however for others specified in the CR, it is required to do restart of the PoDs
- When spec.ldap.caConfigMapRef is defined, and the referenced configmap exist, the named configmap will be mounted on fep-patroni under /tls/ldap.
- When the referenced secret spec.ldap.ldapconfSecretRef exists, the named secret will be mounted on fep-patroni under /etc/openldap. The environment variable LDAPCONF=/etc/openldap/ldap.conf will be exported to the fep-patroni container. If this key is not defined, Operator will create and mount default secret <fep-cluster>-ldapconf with the following content.
- When the referenced configmap spec.ldap2pg.ldap2pgymlConfigMapRef exists, the named configmap will be mounted on fep-patroni under /tmp/.config. If the secret does not exist, Operator will create that named secret with the following content.

While in running state - following value will dynamically appear in the FEPCluster to reflect the cluster status

Field name	Details
status.fepStatus.fepClusterReady	Will be true or false to reflect if the whole cluster is ready. Kubernetes cluster information is fetched to check number of instances 'READY' & 'RUNNING' is equal to number of Configured instances.

Note

"fepClusterReady" flag will be set at first FEPCluster creation time only. fepClusterReady flag does not participate in the next reconciliation loop)

Setting up the database vector transformation feature is automated by applying the FEPCluster YAML as follows. This automatically creates the system administrator (user who loads) for the ONNX model, the owner user (user who imports), and the user (user who executes). Set the name and password for each user.

For detailed usage instructions regarding the in-database vector transformation, refer to the Fujitsu Enterprise Postgres Knowledge Data Management Feature User's Guide.

Changing the enable setting and reapplying the cluster will result in the inference pod being deleted and the vector transformation feature within the database being disabled when changing from True to False. When changing from False to True, a new inference pod will be created and the setting will be enabled. The database will restart when enabled.

```
fep:
vectorTransformation:
  enable: true
  modelRepository:
  modelOwner:
    name: model-owner
    password: password-modelOwner
  modelUser:
    name: model-user
    password-modelUser
  modelLoader:
    name: model-admin
    password: password-modelAdmin
```

To create an inference server, configure the following parameters on the cluster to generate the inference server pod. The pod name is automatically determined based on the database server name. For example, if the database server is named "new-fep", the pod becomes "inference-new-fep". Additionally, configure persistent storage for the inference server. CSI can also be configured for storage. For details, refer to the User's Guide section "Deploying FEPClusters with Cloud-based Secret Management". For the inference server, configure the service for communication between the database server and the inference server pods. You can also choose to encrypt communications using mutual TLS (mTLS). To use it, set `connectionTls.enable` to `True`. If you do not specify the `connectionTls.certificate` parameter, certificates will be automatically generated. When using a created Secret, specify its name as shown in the following sample file. For details, refer to the User's Guide section "Configuration FEP to Perform MTLs". Regarding the resources used by the inference server, calculate them based on the Fujitsu Enterprise Postgres Knowledge Data Management Feature User's Guide and set them as parameters.

```
vectorTransformation:
  inference_server: # Inference server information
    image: repository.io/triton-inference-server
    imagePullsecret: quay-pull-secret
    connectionTls:
      enable: true
      certificate:
        grpcCaName: grpc-cacert
        grpcCertificateName: grpc-cert
        grpcPrivateKey: grpc-key-password
        tritonGrpcCaName: triton-grpc-cacert
        tritonGrpcCertificateName: triton-grpc-cert
        tritonGrpcPrivateKey: triton-grpc-key-password
    inferenceServerPorts:
      grpcPort: 8001
      metricsPort: 8002
storage: # Storage mounted by inference server and model registry
  inferenceVol:
    size: 50Gi
    storageClass: inferece-storage
    accessMode: ReadWriteOnce
  modelRepositoryVol:
    size: 50Gi
    storageClass: inference-storage
    accessMode: ReadWriteOnce
```

1.2 Custom Resource Parameters

This section explains the Custom Resource Parameters.

1.2.1 FEPCluster Custom Resource Parameters

Category	Details
CRD Name	FEPCluster
Definition	///
Operations	Create: <code>kubectl create -f fepcluster.yaml</code> Delete: <code>kubectl delete fepcluster <clusername></code> Update: <code>kubectl apply -f fepcluster.yaml</code> List: <code>kubectl get fepcluster</code>

FEPCluster CR Example

```
apiVersion: fep.fujitsu.io/v2
kind: FEPCluster
metadata:
  name: new-fep
```

```

namespace: new-fep
spec:
  fep:
  ///
    wuC4
    -----END CERTIFICATE-----

```

It should also be noted that all the passwords / passphrase and certificates will be masked after the creation of the CR. This includes

- Also, initial pgAdminPassword: admin-password
- pgpassword: mydbpassword
- pgreplpassword: repluserpwd
- tdepassphrase: tde-passphrase
- pgRewindPassword: rewind_password (Optional - if defined)
- pgMetricsPassword: metrics_password (Optional - if defined)
- pgSecurityPassword (if defined)
- sslpassphrase under sysTde.tdek.kmsDefinition (if defined)
- certificate.key
- certificate.crt
- certificate.cacrt

Values of child CRs at the time of initial deployment of cluster, are stored in FEPCluster under fepChildCrVals, e.g. for Server certificates, Configuration of FEP, User details.

All fields for FEPCluster CR and its child CRs should be managed through FEPCluster CR only. Operator will reflect the changes to respective child CR to be processed. The fields that not allowed to change will not be reflected from parent to child CR and hence will not have any affect.

1.2.2 FEP Cluster Configuration

Configuration of all aspects of FEP Cluster is done through FEPCluster CR only.

All fields for FEPCluster CR and its child CRs should be managed through FEPCluster CR only. Operator will reflect the changes to respective child CR to be processed. The fields that not allowed to change will not be reflected from parent to child CR and hence will not have any affect. Refer to "1.1 FEPCluster Parameter" for details.

All child CRs are marked as internal objects in RedHat OCP and will not appear on console. However, it can be checked on command line using oc or kubectl commands.

Following table shows Child CRs of FEPCluster CR and respective sections in parent CR related to given child CR.

Configuration changes are made in these sections will update allowable fields only in corresponding child CR.

Child CR Name	Relevant sections in FEP Cluster CR
FEPClusterBackup	spec.fepChildCrVal.backup
FEPClusterCert	spec.fepChildCrVal.systemCertificates
FEPClusterConfig	spec.fepChildCrVal.customPgAudit spec.fepChildCrVal.customPgHba spec.fepChildCrVal.customPgParams
FEPClusterUser	spec.fepChildCrVal.sysUsers
FEPClusterVolume	spec.fepChildCrVal.storage

1.2.3 FEPCONFIG Child Custom Resource Parameters

Field	Default	Details
metadata.name	<same-as-in-FEPCluster>	This value is inherited from parent FEPCluster CR
metadata.namespace	<same-as-in-FEPCluster>	This value is inherited from parent FEPCluster CR
spec.customPgAudit	All line specified in spec.fepChildCrVal.customPg Audit of FEPCluster CR	Audit rules can be updated in this section. Requires restart. Note: initial values inherited once only at start. Changes to FEPCONFIG directly
spec.customPgHba	All line specified in spec.fepChildCrVal.customPg Hba of FEPCluster CR	pg_hba rules can be added in this section Note: Inherited once at start. Changes to FEPCONFIG directly
spec.customPgParams	All line specified in spec.fepChildCrVal.customPg Params of FEPCluster CR	All postgres parameters are listed here to overwrite defaults. Note: Inherited once at start. Changes to FEPCONFIG directly
spec.replicationSlots		Optional: Details of replication slots if defined in FEPCluster

Example of FEPCONFIG CR created

```

apiVersion: fep.fujitsu.io/v1
kind: FEPCONFIG
metadata:
  name: new-fep-19ncfg
  namespace: cfg-expt
spec:
  sysExtraLogging: false
  customPgAudit: |
    # define pg audit custom params here to override defaults.
    # if log volume is not defined, log_directory should be
    # changed to '/database/userdata/data/log'
    [output]
    logger = 'auditlog'
    log_directory = '/database/log/audit'
    log_truncate_on_rotation = on
    log_filename = 'pgaudit-%a.log'
    log_rotation_age = 1d
    log_rotation_size = 0
    [rule]

  customPgHba: |
    # define pg_hba custom rules here to be merged with default rules.
    # TYPE      DATABASE      USER      ADDRESS      METHOD
  customPgParams: |+
    # define custom postgresql.conf parameters below to override defaults.
    # Current values are as per default FEP deployment
    shared_preload_libraries='pgx_datamasking,pgaudit,pg_prewarm,pg_stat_statements'
    session_preload_libraries='pg_prewarm'
    max_prepared_transactions = 100
    max_worker_processes = 20
    max_connections = 100
    work_mem = 1MB

```

```

maintenance_work_mem = 20MB
shared_buffers = 128MB
effective_cache_size = 384MB
checkpoint_completion_target = 0.8
pgx_global_metacache = 10MB
temp_buffers = 10MB

# tcp parameters
tcp_keepalives_idle = 30
tcp_keepalives_interval = 10
tcp_keepalives_count = 3

# logging parameters in default fep installation
# if log volume is not defined, log_directory should be
# changed to '/database/userdata/data/log'    log_directory = '/database/log'
log_filename = 'logfile-%a.log'
log_file_mode = 0600
log_truncate_on_rotation = on
log_rotation_age = 1d
log_rotation_size = 0
log_checkpoints = on
log_line_prefix = '%e %t [%p]: [%l-1] user=%u,db=%d,app=%a,client=%h'
log_lock_waits = on
log_autovacuum_min_duration = 60s
logging_collector = on
pgaudit.config_file= '/opt/app-root/src/pgaudit-cfg/pgaudit.conf'
log_replication_commands = on
log_min_messages = WARNING
log_destination = stderr

# wal_archive parameters in default fep installation
archive_mode = on
wal_level = replica
max_wal_senders = 10
wal_keep_size = 1024
wal_sender_timeout = 60s
track_activities = on
track_counts = on

```

1.2.4 FEPUser Child Custom Resource Parameters

Field	Default	Details
metadata.name	<same-as-in-FEPCluster>	This value is inherited from parent FEPCluster CR
metadata.namespace	<same-as-in-FEPCluster>	This value is inherited from parent FEPCluster CR
spec.pgAdminPassword	spec.fepChildCrVal.users.pgAdminPassword of FEPCluster CR	postgres superuser password. Masked once secret is created/changed Note: initial values inherited once only at start. Changes to FEPUser directly
spec.pgdb	spec.fepChildCrVal.users.pgdb of FEPCluster CR	Name of a user database Note: Created once only at start. Cannot be changed
spec.pgpassword	spec.fepChildCrVal.users.pgpassword of FEPCluster CR	Password for superuser for user database pgdb. Masked once secret is created/changed Note: initial values inherited once only at start. Changes to FEPUser directly

Field	Default	Details
spec.pguser	spec.fepChildCrVal.users.pguser of FEPCluster CR	Name of a user database Note: Created once only at start. Cannot be changed
spec.pgrepluser	spec.fepChildCrVal.users.pgrepluser of FEPCluster CR	Name of a database user for replication
spec.pgreplpassword	spec.fepChildCrVal.users.pgreplpassword of FEPCluster CR	Password for pgrepluser
spec.tdepassphrase	spec.fepChildCrVal.users.tdepassphrase of FEPCluster CR	Passphrase for encrypting/decrypting keystore file which contains the TDE encryption key
spec.pgRewindUser	rewind_user	Database user for Rewind
spec.pgRewindUserPassword	rewind_password	Password for database user rewinduser
spec.pgMetricsUser	spec.fepChildCrVal.sysUsers.pgMetricsUser	Optional Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.
spec.pgMetricsPassword	spec.fepChildCrVal.sysUsers.pgMetricsPassword	Optional Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.
spec.pgAdminTls	spec.fepChildCrVal.sysUsers.pgAdminTls	Optional section Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.
spec.pgrepluserTls	spec.fepChildCrVal.sysUsers.pgrepluserTls	Optional section Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.
spec.pgRewindUserTls	spec.fepChildCrVal.sysUsers.pgRewindUserTls	Optional section Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.
spec.pgMetricsUserTls	spec.fepChildCrVal.sysUsers.pgMetricsUserTls	Optional section Refer to " 1.2.1 FEPCluster Custom Resource Parameters " for details.

Example of FEPCluster CR created

```

apiVersion: fep.fujitsu.io/v1
kind: FEPCluster
metadata:
  name: new-fep-19n
  namespace: testswatiprject
spec:
  pgAdminPassword: '*****'
  pgdb: mydb
  pgpassword: '*****'
  pgreplpassword: '*****'
  pgrepluser: repluser
  pguser: mydbuser

```

```

tdepassphrase: '*****'
sysExtraLogging: false
pgRewindUser: rewind_user
pgRewindUserPassword: rewind_password
pgAdminTls:
  certificateName: admin-client-certs-secret
  caName: admin-ssl-rootcert-configmap
  sslMode: prefer
pgrepluserTls:
  certificateName: repluser-client-certs-secret
  caName: repluser-ca-name-configmap
  sslMode: prefer
pgRewindUserTls:
  certificateName: rewinduser-client-certs-secret
  caName: rewinduser-ca-name-configmap
  sslMode: prefer

```

Note

- Password and Passphrase are masked in output from CR. The original values can still be found in the respective Kubernetes secrets and configmaps.
- TDE is enabled by default with given tdepassphrase and must have a value.
- TDE is enabled by using the key tdepassphrase with the desired passphrase. Do not remove this key once TDE is enabled. Otherwise, the database may go into a crash loop. If the Cluster is running on Async Replication and a failover/switchover occurred during the crash loop, there could be data lost. The team is looking at preventing the deletion of this passphrase from Operator even if customer tries to remove it in customer resource.
- Database users and their passwords managed by the FEPUUser CR should not be changed in the SQL interface. Inconsistencies with the information managed by the operator can cause problems with operator operation. If you make changes in the SQL interface, use the SQL interface again to restore the original state.

1.2.5 FEPVolume Child Custom Resource Parameters

1.2.5.1 Create Volumes

Volumes for the cluster nodes(pods) are initially created in accordance with the values set in `fehChildCrVal`' storage section of the parent FEPCluster CR.

The parent FEPCluster CR creates a child FEPVolume CR with the respective startup values and the relevant controller(FEPColume Controller) takes care of creating the required volumes. After initial FEPCluster create, new volume cannot be added later and storageClass or accessModes can not be changed.

Only size of an initially created volume can be changed if and only if underlying storageClass supports dynamic change of size.

Below is the schema of the FEPVolume CR:

Field	Mandatory	Sub-Field	Default	Description
archivewalVol	No	size storageClass accessModes	1Gi Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	Size of the volume,expandable later SC is only set at start Access mode is only set at start Additional details in section 3.2
backupVol	No	size storageClass	2Gi	-do-

Field	Mandatory	Sub-Field	Default	Description
		accessModes	Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	
dataVol	Yes	size storageClass accessModes	2Gi Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	-do-
logVol	No	size storageClass accessModes	1Gi Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	-do-
tablespaceVol	No	size storageClass accessModes	512Mi Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	-do-
walVol	Yes	Size storageClass accessModes	1200Mi Defaults to platform default if omitted Defaults to ReadWriteOnce if omitted	-do-

1.2.5.2 Delete Volumes

Equivalent Kubernetes command: `kubectl delete FEPVolume <cr_name>`

This operation will remove all the PVCs and possibly PVs depending on the default reclaimPolicy of the storageclass used per volume.

With right backup and restore integration by customer, they may not need volumes to be persisted.



Note

Do not delete this CR unless the Cluster has been removed.

Example of FEPVolume CR created

```
apiVersion: fep.fujitsu.io/v1
kind: FEPVolume
metadata:
  name: new-fep-19n
  namespace: testswatiprject
spec:
  archivewalVol:
    size: 1Gi
```

```

backupVol:
  size: 2Gi
dataVol:
  size: 2Gi
logVol:
  size: 1Gi
tablespaceVol:
  size: 512Mi
walVol:
  size: 1Gi
selectedVolList:
- name: data
- name: tablespace
- name: wal
- name: log
sysExtraLogging: false

```

1.2.6 FEPCert Child Custom Resource Parameters

1.2.6.1 Create/ Update Certificates

Certificate secret for the FEP cluster is initially created in accordance with the values set in `fepChildCrVal`' `certs` section of the parent FEPCluster CR.

Below is the schema of the FEPCert CR:

Field	Default	Description
<code>cacrt</code>	Defaults to dummy self signed crt from parent FEPCluster CR	Can be replaced with customer's own CA cert
<code>crt</code>	Defaults to dummy self signed crt from parent FEPCluster CR	Can be replaced with customer's own trusted cert
<code>key</code>	Defaults to dummy key from parent FEPCluster CR	Can be replaced with customer's own key

By default, Operator will create Kubernetes secrets to store the CA Cert, Server Cert and Key file. These files are exposed under the mount point `/fep-certs` in the container. The default FEPCluster template will also set the following postgres parameters in `postgresql.conf`.

```

ssl = on
ssl_cert_file = '/fep-certs/fep.crt'
ssl_key_file = '/fep-certs/fep.key'
ssl_ca_file = '/fep-certs/ca.crt'

```

It should also be possible to change the certificates by end user, by changing ALL `key`, `crt` and `cacrt`. However, user will need to restart the cluster to let change take effect.

1.2.6.2 Delete Certificates

Equivalent Kubernetes command: `kubectrl delete FEPCert <cr_name>`

This operation will remove the secret containing the TLS Certificates and keys for the cluster.

Below is an example CR for certificates to be used by FEP server container

```

apiVersion: fep.fujitsu.io/v1
kind: FEPCert
metadata:
  name: new-fep
  namespace: ansible-operator-poc
spec:

```

key: |-

```
-----BEGIN RSA PRIVATE KEY-----
MIIEowIBAAKCAQEAAI33yvHZws+jta6qpV6wzJqF8odIfTIpCfbrVcUUtLfkJlI
2e4SceTKi603C/I1XuvWlPng5IO65+fQQL006z1/AuQT78YUn/Wlm9x1aHVsv4AN
B5JWWqDQjrRT3o7nRPGXfIlabP0rGE2mJJCVR9nExJ3IeaktgT3sb8YlXvtchyYp
mjdbfxabTz07ig0+6/cwKoRRxOK8Uf7f5euE0cI/490J6r5Rs4lgD8sIQNCUFlTF
YvmAH7gdcSSFBt8NPLUATHEsoFmlW0DKCJWNhTLOht+s6L/1zwTHLjPG2pdkg6W
dgmU5H2pDml8CDNLDv98Aj7i+I5SRKKcVPlnuQIDAQABAoIBAFpQYKlOzw/+BAOb
yMIUpdctIMb/54CR/xR0mVw1DbSjigNVPjHUQvB8YlB2FAITQObgJ006bAv0QdWN
Rb0/v/yYiNJDFjaLjaIAHlO/2+oWrXbFaZqgpVDJhB+elxaZr2x7XGxm+p925k30
l6pvIRY+I8JRKvZiVlVZHwL/R3JOtPr++xMztLVjVOI+f+ySjQ+TzHuaJm49EKxj
cEmmJ28b7QcziXsvKy00f+zbqLiBKXQdZAFU5eEr1BsDRXdRW+KfOXIvftuy4BJZ
voKT+VGHvF/qysswL4+6IA06tpuYnnM0Y2d3sOGowPktCQK0MekYkZL/WmtCjNs
9hodJtECgYEA5EwyhEof4u0Ke5TDp697UCUvXLoOR58FDe/S8XNvScn29jjOkqIg
OMoqo9xAKJTNTzqn5UUDtlx/pgM2NxlPLFijrc0zQlX3So002ryDd9Wni7YKtN16
KJqa536WeZu20EbuAZ+S3GALVylRPetNPNuOmKnF06DjDUGzLNCZy10CgYEA+zfw
952DWuz1U0Z4wvAEqqcgUKXPKrkTXV/iUnjkDkrLYvr0ZofDNTXrdHl+UedFmaOC
cieZn6DNhdz5tKtyysGMH3g/qs9PfoGungvcXsy0Egk04l3x1jc8TTCqLqXZYAq
HMsx5ln+r58oncPtYsUOr9qQ6Pbc2CstTbFJA0CgYEAjGesuLiAB/jknfEzjXjG
PdhQUxb8Vye864Az2lah9t/kJzFyIAziAeqZ5GE7t247AGFTBRTHHI8e1Qoemi3P
Wbc9GVIbFsl1IYbcIDpUIyrKPEP805QEXtoNLxXTfGajRGKiVY87spjCAJ+W2ZhO
e/lit5GYxfGQCYQA2yuBmOUCgYANrkr2YR1axaCk+NlSu6oTdmPu6M5x7PNQE7O
OtMaKjua9lppvIzFGAdMDUteoeEAE7ZR1xnwfb6PDLUpJdIYAqgrlyfPt8qkjaZ
Tv56yZ7CwL0pbF8m6nwqRrZoDplwwraEvvvxFKFKGY/k3kChlpTakdjEoDjn3gDi
RnWeVQKbGCneMSzucei5LrppRtRaJw/Bt1l8q1PMLX3W7dxQ3cLwpmL0n0m5lFp
PIZ44zYK8R6fu4+/sRlfaIgr86Ugeufp6YNxyNR0KxUGza5vDIu50ftwWtBeg+UK
Z8lLWNdX6pp7WmuJmF3HlDrkBBauYMUKZ4UxUYtelgHERMePIxwb
-----END RSA PRIVATE KEY-----
```

crt: |-

```
-----BEGIN CERTIFICATE-----
MIIDUTCCAjpgAwIBAgIRAMocw3qMoHrD6gRvMppMkMwDQYJKoZIhvcNAQELBQAw
NzEQMA4GA1UECgwHRnVqaXRzdTEjMCEGA1UEAwwaRkVQIFJvb3QgQ0EgZm9yIETl
YmVybmV0ZXMwHhcNMjEwMjM2MDQzMjM2WhcNMjEwMjM2MDQzMjM2WjA/MRAwDgYD
VQQKEwdGdWppdHNLMSswKQYDVQDEYjGVUupJVFNvIEVudGvYchJpc2UGUG9zdGdy
ZXMGU2VydmVyMIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAAI33yvH
Zws+jta6qpV6wzJqF8odIfTIpCfbrVcUUtLfkJlI2e4SceTKi603C/I1XuvWlPng
5IO65+fQQL006z1/AuQT78YUn/Wlm9x1aHVsv4ANB5JWWqDQjrRT3o7nRPGXfIlab
P0rGE2mJJCVR9nExJ3IeaktgT3sb8YlXvtchyYpmjdbfxabTz07ig0+6/cwKoRR
xOK8Uf7f5euE0cI/490J6r5Rs4lgD8sIQNCUFlTFYvmAH7gdcSSFBt8NPLUATHE
soFmlW0DKCJWNhTLOht+s6L/1zwTHLjPG2pdkg6WdgmU5H2pDml8CDNLDv98Aj7i
+I5SRKKcVPlnuQIDAQABAwTjAdBgNVHSUEFjAUBgggrBgEFBQcDAQYIKwYBBQUH
AwIwDAYDVROTAQH/BAIwADAFBgNVHSMEGDAwBQcwrrU00u+FhIUuVDRDRcQRsi6
ZjANBgkqhkiG9w0BAQsFAAOCAQEAm5dxBoI9pScOCvRAchg4CprdrDSJb9K6yB30
nCAxnm47iHeXnY3WlnI388kHu8DU704ba1tJbGs3KY9KzioPk43pU12jWk01onoF
+mTDjx/Ef1cYWA9r5q/LtgTa6Q2sxV4O2x67QW82aAnax034dV5zWCPiVaovZBV
HRT+Bgcg3r2vD1RGKK2nl1aYJtWh01SZubam+VttdZ/vbM9o0JctxmImsetBXjkY
KteePdQtLL5o03JhyXWyrShCq+HmMkf2KgyY8gvdyGcP4eLQdBwCw40LcnVq6UjT
0kJycJEKngMvademq1ZWHGaiYB7hyT6GhgIcHUJ2cKrPgbEhlQ==
-----END CERTIFICATE-----
```

ca crt: |-

```
-----BEGIN CERTIFICATE-----
MIIDTzCCAjegAwIBAgIUySSQ8i74US5g+1+Z7ChuaDgkZnEwDQYJKoZIhvcNAQEL
BQAwNzEQMA4GA1UECgwHRnVqaXRzdTEjMCEGA1UEAwwaRkVQIFJvb3QgQ0EgZm9y
IETlYmVybmV0ZXMwHhcNMjEwMjM2MDQzMjM2WhcNMjEwMjM2MDQzMjM2WjA3MRAw
DgYDVQKDAAdGdWppdHNLMSswIQYDVQDDbGRVAgUm9vdCBDQSBmb3Igs3ViZXJv
ZXRlc2CCASiWdQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAMs97gUF0xkUzCgL
7MiiDju9ySr/ziwjcYU7jA9ML+SLmftMs3HtcYbAmSntqI+MDBSR/FAJTOoytuT
pV+mCFCg2YAjDpliHpeNcUpbryy4YMChF3+MovkIwGCKsxo5rhiWhGmoBYpA48P
4Xe8SPlzqMzhFvNeKzyiUhvjutS2Y1Ss38lsTaurFPx64vQ2PaC54XzdwMptXtpb
tYmWSzCpJWwxZ6lF3vitdA2w0tnBWNyctAd0+RIM/fvArxiIqseAux9t0uogm5to
lRihvekuxOpXBPEqtIYQ4j9XUW2JH8vUDnzPkPvjrq+A3Ug8OyyfGVrW7+VYXozu
c4aP7P0CAwEAAANTMFEwHQYDVR0OBBYEFBzCutQ7S74WEhS5V2sNEJBGyLpmMB8G
AlUdIwQYMBaAFBzCutQ7S74WEhS5V2sNEJBGyLpmMA8GA1UdEWEB/wQFMAMBAf8w
-----END CERTIFICATE-----
```

```
DQYJKoZIhvcNAQELBQADggEBAMDwD85RAaWEBptFgLzKw+9xEUy1vcZaonAuA1qc
T342XTueyAugxkC11HwdCGgGS34VyctfMGqj4AW6pA2ez4tLrbOps4DmV4sw8uBL
8pgRDgfly3ob9FEg2wa0hmrwX9 jH5Bt4vysUE2785uPAQaspT2UNTbXs85BUi1T
sKId2Rtil6an281Z81wyWVI6Jm2D4MG0mbsiGcTP1Ctdg/Ul jvDYmX1Avd4vNh1
k9hDal3TgDqJKgKdTIcmZoNQdpEVgFc00h9AEUy5AuLqxHq60dLfZ6ESGP1MI7Lm
i4PzYbChBmOe+7TnHcPSyrnehs66Ik+oifRd82eYS7vKjFw=
-----END CERTIFICATE-----
```

Note

This approach of specifying FEP Certs is getting deprecated. Should follow Secrets as referred in section to configure Certs for Server, Patroni and Users.

1.2.7 FEPBackup Child Custom Resource Parameters

Field	Default	Details
apiVersion	fep.fujitsu.io/v1	Fixed
kind	FEPBackup	Fixed
metadata.name	<clustername>	Enter the CR name.
spec.pgbackrestParams	" "	" " It is fixed, and the parameter set in pgbackrest.conf is described from the line below.
spec.schedule.num	Integer	Number of schedules to set The maximum number of backup schedules is 5.
spec.scheduleN.schedule	-	Write the date and time of the Nth schedule in cron format. The date and time is UTC time.
spec.scheduleN.type	full/incr	full: Perform a full backup (Back up the contents of the database cluster). incr – Perform an incremental backup (Back up only the database cluster files that were changed to the last backup migration).
spec.preScript	" "	This parameter must specify a default value.
spec.postScript	" "	This parameter must specify a default value.

Example of FEPBackup CR created

```
apiVersion: fep.fujitsu.io/v1
kind: FEPBackup
metadata:
  name: fepcluster-backup
spec:
  schedule:
    num : 2
  schedule1:
    schedule : "0 0 1 * *"
    type : "full"
  schedule2:
    schedule : "0 0 1-6 * *"
    type : "incr"
  preScript: " "
  postScript: " "
  pgbackrestParams: |
    # define custom pgbackrest.conf parameters below to override defaults.
```

```
[global]
repol-retention-full = 30
repol-retention-full-type = time
...
```

1.2.8 FEPRestore Custom Resource Parameters

Field	Default	Details
apiVersion	fep.fujitsu.io/v1	Fixed
kind	FEPRestore	Fixed
metadata.name	-	Enter the CR name.
spec.fepVersion		Optional To use FEPRestore image of given version. Possible values: 14, 15, 16, 17 & 18
spec.image	<current-released-image>	FEP restore container image to be used quay.io/fujitsu/fujitsu-enterprise-postgres-18-restore:ubi9-18-1.0 It is optional. Image is left blank by default. In such a case, it will pick up URL of image from operator container environment. If you specify the image, Operator will take that image to deploy container
spec.imagePullPolicy	IfNotPresent	
spec.mcSpec.limits	cpu: 0.2 memory: "300Mi"	
spec.mcSpec.requests	cpu: 0.1 memory: "200Mi"	
spec.fromFEPcluster	<from_clustername>	The name of the FEPcluster from which to restore
spec.toFEPcluster	<to_clustername>	Specifies the name of the FEP cluster to restore to. When restoring to an existing cluster, do not specify the line of this parameter.
spec.restoretype	latest/PITR	latest - Restore Latest State PITR - Date-Time Restore
spec.restoredate	-	If spec.restoretype is PITR, specify the day of PITR (UTC) in YYYY-MM-DD format Be sure to use single quotes. Example) '2020-11-25'
spec.restoretime	-	If spec.restoretype is PITR, specifies the PITR time (UTC) in HH: MM: SS format Be sure to use single quotes. Example) '02:50:43'
spec.restoreTargetRepo		Optional If you are using multiple repositories, specify the repository from which to restore.

Field	Default	Details
		If not specified, "1" is substituted.
spec.changeParams.fepChildCrVal.backup.pgbackrestParams		Optional Specify this to change the spec.fepChildCrVal.backup.pgbackrestParams setting in FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.backup.pgbackrestKeyParams		Optional Specify this to change the spec.fepChildCrVal.backup.pgbackrestKeyParams setting in FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.backup.caName		Optional Specify if you want to change the spec.fepChildCrVal.backup.caName setting of FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.backup.repoKeySecretName		Optional Specify if you want to change the spec.fepChildCrVal.backup.repoKeySecretName setting of FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.backupVol		Optional Specify this to change the spec.fepChildCrVal.storage.backupVol setting in FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.archivewalVol		Optional Specify this option to change the spec.fepChildCrVal.storage.archivewalVol setting for FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.dataVol		Optional Specify this to change the spec.fepChildCrVal.storage.dataVol setting for FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.walVol		Optional Specify this to change the spec.fepChildCrVal.storage.walVol setting for FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.logVol		Optional Specify this to change the spec.fepChildCrVal.storage.logVol setting for FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fepChildCrVal.storage.tablespaceVol		Optional Specify this to change the spec.fepChildCrVal.storage.tablespaceVol setting for FEPClusterCR when restoring to a new DB cluster.
spec.changeParams.fep.monitoring.fepExporter.tls.certificateName		Optional Specify this to change the spec.fep.monitoring.fepExporter.tls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an

Field	Default	Details
		automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.monitoring.fepExporter.tls.caName		Optional Specify this to change the spec.fep.monitoring.fepExporter.tls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.monitoring.prometheus.tls.certificateName		Optional Specify this to change the spec.fep.monitoring.prometheus.tls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.monitoring.prometheus.tls.caName		Optional Specify this to change the spec.fep.monitoring.prometheus.tls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.remoteLogging.tls.certificateName		Optional Specify this to change the spec.fep.remoteLogging.tls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.remoteLogging.tls.caName		Optional Specify this to change the spec.fep.remoteLogging.tls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.patroni.tls.certificateName		Optional Specify this to change the spec.fep.patroni.tls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses

Field	Default	Details
		an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.patroni.tls.caName		Optional Specify this to change the spec.fep.patroni.tls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.patroni.tls.privateKeyPassword		Optional Specify this to change the spec.fep.patroni.tls.privateKeyPassword setting of FEPClusterCR when restoring to a new database cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.postgres.tls.certificateName		Optional Specify this to change the spec.fep.postgres.tls.certificateName setting of FEPClusterCR when restoring to a new database cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.postgres.tls.caName		Optional Specify this to change the spec.fep.postgres.tls.caName setting of FEPClusterCR when restoring to a new database cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.postgres.tls.privateKeyPassword		Optional Specify this to change the spec.fep.postgres.tls.privateKeyPassword setting of FEPClusterCR when restoring to a new database cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgAdminTls.certificateName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.

Field	Default	Details
spec.changeParams.fepChildCrVal.sysUsers.pgAdminTls.caName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgAdminTls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgAdminTls.sslMode		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgAdminTls.sslMode setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgAdminTls.privateKeyPassword		Optional Specify this to change the spec.fepChildCrVal.sysUsers.pgAdminTls.privateKeyPassword setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgrepluserTls.certificateName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgrepluserTls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgrepluserTls.caName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgrepluserTls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgrepluserTls.sslMode		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgrepluserTls.sslMode setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore

Field	Default	Details
		destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgrepluserTls.privateKeyPassword		Optional Specify this to change the spec.fepChildCrVal.sysUsers.pgrepluserTls.privateKeyPassword setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgMetricsUserTls.certificateName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgMetricsUserTls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgMetricsUserTls.caName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgMetricsUserTls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgMetricsUserTls.sslMode		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgMetricsUserTls.sslMode setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgMetricsUserTls.privateKeyPassword		Optional Specify this to change the spec.fepChildCrVal.sysUsers.pgMetricsUserTls.privateKeyPassword setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgRewindUserTls.certificateName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgRewindUserTls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.

Field	Default	Details
		eName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgRewindUserTls.caName		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgRewindUserTls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgRewindUserTls.sslMode		Optional Specify to change the spec.fepChildCrVal.sysUsers.pgRewindUserTls.sslMode setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.pgRewindUserTls.privateKeyPassword		Optional Specify this to change the spec.fepChildCrVal.sysUsers.pgRewindUserTls.privateKeyPassword setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.vectorizerTls.certificateName		Optional Specify to change the spec.fepChildCrVal.sysUsers.vectorizerTls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.vectorizerTls.caName		Optional Specify to change the spec.fepChildCrVal.sysUsers.vectorizerTls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.

Field	Default	Details
spec.changeParams.fepChildCrVal.sysUsers.vectorizerTls.sslMode		Optional Specify to change the spec.fepChildCrVal.sysUsers.vectorizerTls.sslMode setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.sysUsers.vectorizerTls.privateKeyPassword		Optional Specify this to change the spec.fepChildCrVal.sysUsers.vectorizerTls.privateKeyPassword setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.secretStore.azureProvider.fepSecrets		Optional Specify this to change the spec.fepChildCrVal.secretStore.azureProvider.fepSecrets setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.secretStore.awsProvider.fepSecrets		Optional Specify this to change the spec.fepChildCrVal.secretStore.awsProvider.fepSecrets setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.secretStore.csi.gcpProvider.fepSecrets		Optional Specify this to change the spec.fepChildCrVal.secretStore.csi.gcpProvider.fepSecrets setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fepChildCrVal.secretStore.csi.vaultProvider.fepSecrets		Optional Specify this to change the spec.fepChildCrVal.secretStore.csi.vaultProvider.fepSecrets setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically

Field	Default	Details
		generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.autoTuning.prometheus.tls.certificateName		Optional Specify this to change the spec.fep.autoTuning.prometheus.tls.certificateName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.
spec.changeParams.fep.autoTuning.prometheus.tls.caName		Optional Specify this to change the spec.fep.autoTuning.prometheus.tls.caName setting of FEPClusterCR when restoring to a new DB cluster. If the restore source FEP cluster uses an automatically generated certificate and the restore destination FEP cluster also uses an automatically generated certificate, do not specify this parameter line itself.

Example of FEPRestore CR created

```

apiVersion: fep.fujitsu.io/v1
kind: FEPRestore
metadata:
  name: feprestore
spec:
  mcSpec:
    limits:
      cpu: 200m
      memory: 300Mi
    requests:
      cpu: 100m
      memory: 200Mi
  fromFEPcluster: fecluster1
  toFEPcluster: fecluster2
  restoreType: latest
  imagePullPolicy: IfNotPresent

```

Example of Point-In-Time-Recovery using FEPRestore CR

```

apiVersion: fep.fujitsu.io/v1
kind: FEPRestore
metadata:
  name: feprestore
spec:
  mcSpec:
    limits:
      cpu: 300m
      memory: 700Mi
    requests:
      cpu: 200m
      memory: 512Mi
  fromFEPcluster: feclusterA
  toFEPcluster: feclusterB

```

```

restoretype: PITR
restoredate: 2020-11-25
restoretime: 02:50:43
imagePullPolicy: IfNotPresent

```

Note

Upon successful completion, custom resources in FEPRestore are automatically deleted.

You can specify `spec.changeParams` in the FEPRestore custom resource to modify the definition from the source to build a new FEPCluster and restore the data.

This allows you to mount another storage in the new cluster, for example, to expand the PVC size, even if you are using storage that does not support PVC extensions.

Example of a FEPRestore Custom Resource for Modifying the Storage Class and Storage Capacity of a FEPCluster "source-cluster"

```

apiVersion: fep.fujitsu.io/v1
kind: FEPRestore
metadata:
  name: feprestore
spec:
  mcSpec:
    limits:
      cpu: 300m
      memory: 700Mi
    requests:
      cpu: 200m
      memory: 512Mi
  fromFEPCluster: source-cluster
  toFEPCluster: new-cluster
  restoretype: latest
  changeParams:
    fepChildCrVal:
      storage:
        dataVol:
          size: 50 Gi
          storageClass: new-storage

```

1.2.9 FEPPgpool2 Custom Resource Parameters

Equivalent Kubernetes command: `kubectl create FEPPgpool2`

This operation will create a PGPool2 with supplied information.

Field	Default	Details
<code>apiVersion</code>	<code>fep.fujitsu.io/v1</code>	Fixed You cannot make changes after it has been created.
<code>kind</code>	<code>FEPPgpool2</code>	Fixed You cannot make changes after it has been created.
<code>metadata.name</code>	-	List the name of the FEP Pgpool2 container. You cannot make changes after it has been created.
<code>metadata.namespace</code>	-	Specify the namespace of the environment where you want to deploy the operator. You cannot make changes after it has been created.
<code>spec.fepVersion</code>		Optional

Field	Default	Details
		To use FEPPgpool2 image of given version. Possible values: 14, 15, 16, 17 & 18 Changes made after creating a custom resource will not take effect.
spec.image	<current-released-image>	FEPPgpool2 container image to be used quay.io/fujitsu/fujitsu-enterprise-postgres-18-pgpool2:ubi9-18-1.0 It is optional. Image is left blank by default. In such a case, it will pick up URL of image from operator container environment. If you specify the image, Operator will take that image to deploy container.
spec.count	2	List the number of FEP Pgpool2 containers to create.
spec.serviceport	9999	Describes the TCP port for connecting to the FEP Pgpool2 container.
spec.statusport	9898	Identifies the TCP port for connecting to the PCP process.
spec.limits.cpu	400m	List the number of CPUs (restriction) to allocate to resources.limits.cpu.
spec.limits.memory	512Mi	Specifies the memory size (restriction) to allocate to resources.limits.memory.
spec.requests.cpu	200m	List the number of CPUs (request) to allocate to resources.requests.cpu.
spec.requests.memory	256Mi	Specifies the memory size (request) to allocate to resources.requests.memory
spec.fepclustername	new-fep	Enter the FEPCluster name to connect to.
spec.customhba		If you want to use pool_hba.conf, describe what pool_hba.conf should contain from the line below.
spec.customparams	listen_addresses = '*' pcp_listen_addresses = '*' num_init_children = 32 reserved_connections = 0 enable_pool_hba = off allow_clear_text_frontend_auth = off authentication_timeout = 80 backend_weight0 = 1 backend_weight1 = 1 backend_flag0 = 'ALWAYS_PRIMARY' backend_flag1 = 'DISALLOW_TO_FAILOVER' connection_cache = on max_pool = 4	" " and the Pgpool-II parameters. Refer to " Pgpool-II parameters " for detail.

Field	Default	Details
	<pre>listen_backlog_multiplier = 2 serialize_accept = off child_life_time = 300 client_idle_limit = 0 child_max_connections = 0 connection_life_time = 0 reset_query_list = 'ABORT; DISCARD ALL' client_min_messages = info log_min_messages = debug1 log_statement = on log_per_node_statement = on log_client_messages = on log_hostname = on log_connections = on log_line_prefix = '%t: pid %p: ' load_balance_mode = on ignore_leading_white_space = on white_function_list = " black_function_list = 'currval,lastval,nextval,setval' black_query_pattern_list = " database_redirect_preference_ list = " app_name_redirect_preferenc e_list = " allow_sql_comments = off disable_load_balance_on_writ e = 'transaction' statement_level_load_balance = on sr_check_period = 0 sr_check_user = 'postgres' delay_threshold = 0 log_standby_delay = 'none' ssl = on ssl_ciphers = 'HIGH:MEDIUM:+3DES:! aNULL' ssl_prefer_server_ciphers = off ssl_ecdh_curve = 'prime256v1'</pre>	

Field	Default	Details
	ssl_dh_params_file = " relcache_expire = 0 relcache_size = 256 check_temp_table = catalog check_unlogged_table = on enable_shared_relcache = off relcache_query_target = primary wd_port0 = 9000 failover_on_backend_error = off	
spec.custompcp	" "	If you use the pcp command, " " and the contents of pcp.conf from the line below.
spec.customsslkey	" "	If you want to do it, " " and the Beethoven key content in the line below. Changes made after creating a custom resource will not take effect.
spec.customsslcert	" "	If you want to do it, " " and the contents of the public x 509 certificate from the line below. Changes made after creating a custom resource will not take effect.
spec.customsslcacert	" "	If you want to do it, " " and the following lines describe the contents of the CA root certificate in PEM format. Changes made after creating a custom resource will not take effect.
spec.customlogsize	100 Mi	Specifies the persistent volume size for log output. Changes made after creating a custom resource will not take effect.
spec.storageclassname		Specifies the storage class for log output. NFS storage is not available if you enable the following parameters: <ul style="list-style-type: none"> - enable_shared_relcache - memory_cache_enabled Changes made after creating a custom resource will not take effect.
spec.clientAuthMethod		Optional Specifies the method for client authentication. Define "scram" to use scram-sha-256 authentication. Otherwise, the client authentication method is still md5. Changes made after creating a custom resource will not take effect.
spec.scram.pgpoolkeySecret		Optional

Field	Default	Details
		<p>Describes the name of the secret that stores the key for use in encryption/decryption.</p> <p>Can only be specified at creation time.</p> <p>If you change the contents of the specified secret, a restart is required.</p> <p>Changes made after creating a custom resource will not take effect.</p>
spec.scram.userinfoSecret		<p>Optional</p> <p>Write the name of the secret that contains the user name you added and the password that corresponds to that user.</p> <p>Can only be specified at creation time.</p> <p>Changes made after creating a custom resource will not take effect.</p>

Pgpool-II parameters

The parameters that can be specified are shown in the table below. For details on the parameters, refer to the Pgpool-II manual.

Category	Parameter name (Specified format)	Restart required after change
Connection settings	listen_addresses (string)	Y
	pcp_listen_addresses (string)	Y
	num_init_children (integer)	Y
	reserved_connections (integer)	Y
Authentication settings	enable_pool_hba (boolean)	
	allow_clear_text_frontend_auth (boolean)	
	authentication_timeout (integer)	
Backend settings	backend_weight0 (floating point)	
	backend_weight1 (floating point)	
	backend_flag0	
	backend_flag1	
Connection pooling	connection_cache (boolean)	Y
	max_pool (integer)	Y
	listen_backlog_multiplier (integer)	Y
	serialize_accept (boolean)	Y
	child_life_time (integer)	Y
	client_idle_limit (integer)	
	child_max_connections (integer)	Y
	connection_life_time (integer)	Y
reset_query_list (string)		
Error reporting and log acquisition	client_min_messages (enum)	
	log_min_messages (enum)	
	log_statement (boolean)	

Category	Parameter name (Specified format)	Restart required after change
	log_per_node_statement (boolean)	
	log_client_messages (boolean)	
	log_hostname (boolean)	
	log_connections (boolean)	
	log_error_verbosity (enum)	
	log_line_prefix (string)	
Load sharing settings	load_balance_mode (boolean)	Y
	ignore_leading_white_space (boolean)	
	white_function_list (string)	
	black_function_list (string)	
	black_query_pattern_list (string)	
	database_redirect_preference_list (string)	
	app_name_redirect_preference_list (string)	
	allow_sql_comments (boolean)	
	disable_load_balance_on_write (string)	Y
	statement_level_load_balance (boolean)	
Health check	connect_timeout (integer)	
Streaming replication check	sr_check_period (integer)	
	sr_check_user (string)	
	sr_check_password (string)	
	sr_check_database (string)	
	delay_threshold (integer)	
	log_standby_delay (string)	
Secure Socket Layer (SSL)	ssl (boolean)	Y
	ssl_ciphers (string)	Y
	ssl_prefer_server_ciphers (boolean)	Y
	ssl_ecdh_curve (string)	Y
	ssl_dh_params_file (string)	Y
Other parameters	relcache_expire (integer)	Y
	relcache_size (integer)	Y
	enable_shared_relcache (boolean)	Y
	relcache_query_target (enum)	
	check_temp_table (enum)	
	check_unlogged_table (boolean)	

1.2.10 FEPAAction Custom Resource Parameters

Specify parameters in the format described below.

Custom resource spec	Default	Change effect
spec.targetClusterName		Must specify target FEP Cluster name within namespace mentioned in metadata.
spec.targetPgpool2Name		Must specify target FEPPgpool2 name within namespace mentioned in metadata when using pgpool2_restart.
spec.fepAction.type		Must specify action type. Supported action types are: restart pod_restart reload list switchover failover pgpool2_restart backup open_tde_masterkey create_extension alter_extension update_admin_password backup_expire promote_standby update_multi_master_replication fixed_stats
spec.fepAction.args		Must specify arguments needed for given action. For details of args corresponding to each action refer to " 1.2.10.1 FEPAction Specific Operation Details ".
spec.fepAction.backupType	full	Options If you specify backup for fepAction.type, the type of backup is used. full : Performs a full backup (backs up the contents of the database cluster). incr : Perform an incremental backup (Back up only the database cluster files that were changed during the last backup migration).
spec.fepAction.backupRepo	1	Options Gets a backup in the specified repository. The range is 1 to 256.
spec.sysExtraLogging		To turn extra debugging on, set value to true. It can be turned on/off at any time.
spec.args.targetReplication		Options Specify the replication name to modify. If not specified, attempts will be made to modify all replicas defined in the bidirectional replication definition file.

After execution of FEPAction CR, status is reflected in fepStatus field that is dynamically inserted in current FEPAction CR as needed. fepStatus field used for FEPAction CR are described here

fepStatus (with possible values)	Remarks
fepActionStatus:	fepStatus is inserted at the top of FEPAction CR

fepStatus (with possible values)	Remarks
fepActionCondition: Success Failure	This flag is inserted in fepAction CR to reflect success or failure of requested action
fepActionResult: > "details"	The result contains verbose details corresponding to the specific action been executed. Should be noted that it is either plain text of HTTP output.
processedTimestamp: <time stamp>	Denotes time of action execution by the Operator

```

apiVersion: fep.fujitsu.io/v1
kind: FEPAction
fepActionStatus:
  fepActionCondition: Success
metadata:
  name: new-fep-reload-action
  namespace: myns
spec:
  fepAction:
    args:
      - new-fep-sts-0
      - new-fep-sts-1
    type: reload
  sysExtraLogging: false
  targetClusterName: new-fep

```

 **Note**

- Please do not use the FEPAAction to perform a switchover or restart while executing backup. Failed to get the backup.
- You must create a new FEPAAction custom resource for each operation.

1.2.10.1 FEPAAction Specific Operation Details

Action type - reload

The reload action will manually reload the FEP database on the targeted FEPCluster.

"reload" action type expects users to specify the name of individual FEP pods that they want to run the database reload operation on. They specify that in the args section under the FEPAAction CR spec as below :

```

spec:
  fepAction:
    args:
      - nf-131851-sts-0
      - nf-131851-sts-1
    type: reload
  targetClusterName: nf-131851

```

Action type - restart

The restart action will manually restart the FEP database on the targeted FEPCluster.

"restart" action type expects users to specify the name of individual FEP pods that they want to run the database restart operation on. They specify that in the args section under the FEPAAction CR spec as below:

```

spec:
  fepAction:
    args:
      - nf-131851-sts-0

```

```
- nf-131851-sts-1
type: restart
targetClusterName: nf-131851
```

Action type - pod_restart

The pod_restart action will restart specified list of POD for given target cluster. User can specify key word 'ALL' under 'args' section to restart all pods in target cluster. Alternatively, user can give the list of pods to be started in target cluster. User should either give ALL or the list of the pods.

This action restarts the replica pods first. Once all replicas have been restarted, it switches over the mastership to one of the replica before restarting old master pod. If it is a single node cluster, master will be restarted in its current state. This action is automatically created to restart pods when image or machine specs are changed for fep or backup container depending on autoPodRestart flag in FEPCluster CR (Refer to "[1.2.1 FEPCluster Custom Resource Parameters](#)" for details.):

```
spec:
fepAction:
args:
- nf-131851-sts-0
- nf-131851-sts-1
type: pod_restart
targetClusterName: nf-131851
```

Action type - list

The list action will return the status of the targeted FEPCluster.

"list" action type expects users to specify just the target cluster name to list the details of the same. Looks like below:

```
spec:
fepAction:
type: list
targetClusterName: nf-131851
```

Action type - switchover

The switchover action performs a manually switchover of the current leader/primary database from one pod to another pod of the targeted FEPCluster.

"switchover" action type expects users to specify the name of the target cluster that they want to perform switchover. args section is not required for switchover as FEPACTION operator code will internally find it and promote new master. FEPACTION CR spec as below:

```
spec:
fepAction:
type: switchover
targetClusterName: nf-131851
```

Action type - failover

The failover action performs a manually failover of the current primary database from one pod to another pod of the targeted FEPCluster. The difference between switchover and failover is that, switchover expects the primary database is running at the time whereas failover can force switchover of primary role from a non-responding pod to another pod. Note that failover is a disruptive action and may cause data lost.

"failover" action type expects users to specify the names of the candidate pods that they want to failover to. They specify that in the args section under the FEPACTION CR spec as below:

```
spec:
fepAction:
args:
- nf-131851-sts-1
- nf-131851-sts-2
type: failover
targetClusterName: nf-131851
```

Here, nf-131851-sts-1 and nf-131851-2 are the candidate pods to failover to. In this example, the current primary pod would be nf-131851-sts-0.

Action type - pgpool2_restart

"pgpool2_restart" action type expects users to specify the name of individual FEPPgpool2 resource that they want to restart operation on. They specify that in the targetPgpool2Name section under the FEPACTION CR spec as below:

```
spec:
  fepAction:
    type: pgpool2_restart
    targetPgpool2Name: nf-131851-pgpool2
```

Action type - backup

The "backup" action performs a backup on the target FEPCluster.

The "backup" action type requires you to specify the type of backup and the repository in which to store the data.

In the fepAction section of the FEPACTION custom resource specification, specify the following:

```
spec:
  targetClusterName: new-fep
  fepAction:
    type: backup
    backupType: full
    backupRepo: 1
```

Note

- Regardless of how the backup was performed (scheduled or FEPACTION), if backups were performed at the same time by the same FEPCluster, subsequent backups will fail.
- If the backup repository Retention Option is specified in the FEPCluster custom resource spec.fepChildCrVal.backup.pgbackrestParams, the backup files obtained by the FEPACTION are also deleted as specified by the option.

Action type - open_tde_masterkey

The open_tde_masterkey action opens a keystore for a TDE-enabled target cluster.

The "open_tde_masterkey" action type requires the user to specify the name of the target cluster on which the keystore will be opened. The args section is not required.

Specify the following:

```
spec:
  targetClusterName: nf-131851
  fepAction:
    type: open_tde_masterkey
```

Action type - create_extension

The create_extension action executes "CREATE EXTENSION" on the target FEPCluster and installs the extension.

In fepAction.args, specify the "extension name, version", "database", "schema", and "apply CASCADE options" to be installed.

Parameters specified by args	Description
extension	Required Specifies the extension and version to be installed.
version	Option

Parameters specified by args	Description
	Specifies the version of the extension to be specified for the VARSION option. If omitted, the VARSION option is omitted.
database	Option Specifies the database to install. If omitted, install in the "postgres" database.
schema	Option Specifies the schema to be installed, which is specified in the SCHEMA option. If omitted, the SCHEMA option is omitted.
cascade	Option true or false Enables or disables the CASCADE option for CREATE EXTENSION. If omitted, false.

An example specification is shown below.

```
spec:
  targetClusterName: new-fep
  fepAction:
    type: create_extension
    args:
      extension: "vci"
      version: "2.0"
      database: "mydb"
      schema: "public"
      cascade: "true"
```

Action type - alter_extension

The alter_extension action executes "ALTER EXTENSION" on the target FEPCluster to change the definition of the extension.

You can execute ALTER EXTENSION on the specified FEPCluster container by applying fepAction.args.version with the version to be updated.

Parameters specified by args	Description
extension	Required Specifies the installed extensions whose definition you want to change.
database	Option Specifies the database whose extension you want to change. If omitted it will be installed into the "postgres" database.
version	Option Specifies the version of the installed extension to update. If omitted, it is updated to the latest version available at the time.

Here is an example of a FEPAction custom resource that updates the version of pg_stat_statements: When a custom resource is applied, the version of pg_stat_statements is updated to the specified version.

```
spec:
  targetClusterName: new-fep
  fepAction:
    type: alter_extension
    args:
      extension:pg_stat_statements
```

```
version:1.8
database:sample
```

Action type - update_admin_password

The update_admin_password action redefines the password for SUPERUSER "postgres" on the target FEPCluster with a random value.

This action will be executed when the FEPCluster custom resource spec.fepChildCrVal.sysUsers.pgAdminPassword is not defined.

An example specification is shown below.

```
spec:
  fepAction:
    type: update_admin_password
    targetClusterName: new-fep
```

Action type - backup_expire

You can run the "pgbackrest expire" command on the FEPPod to remove expired backups.

The "pgbackrest expire" command is normally run automatically upon a successful backup, but it can be run by the user, for example, when the definition of the number of generations to retain for a backup is reduced, and the backup data can be deleted so that the number of retained generations conforms to the changed definition.

If you want to reduce the number of backup retention generations and free up disk space, apply "backup_expire" in the FEPAction after changing the retention setting for backup data under the FEPCluster custom resource fepChildCrVal.backup.pgbackrestParams.

You can specify the repository from which to remove the backup by specifying args.repo.

Parameters specified by args	Description
repo	Options Specified value: integer Specifies the number of the repository from which to remove the backup. If omitted, delete the backup for all backup repositories.

Note

The number of the backup repository must be N for repoN-type, as defined in the FEPCluster custom resource spec.fepChildCrVal.backup.pgbackrestParams.

The following is an example of changing the retention setting for backup data in a FEPCluster custom resource.

You want to reduce the number of backup generations stored in S3.

```
spec:
  fepChildCrVal:
    backup:
      pgbackrestParams:
        repo2-type=s3
        repo2-retention-full=5 # Change it to the number of generations you want to keep
        repo2-retention-full-type=time
```

The following is an example of a FEPAction custom resource that reduces the number of backup generations:

Since the backup repository for s3 is specified as repo2-type in pgbackrestParams, specify 2 for spec.fepActoin.repo.

```
apiVersion: fep.fujitsu.io/v1
kind: FEPAction
metadata:
  name: backup-expire-action
spec:
```

```
targetCluster: new-fep
fepAction:
  type: backup_expire
  args:
    repo: 2
```

Action type - promote_standby

promote_standby promotes the FEP database in the disaster recovery environment from Standby DB to Primary DB. You must specify the DB cluster to be promoted.

The following shows a specification example.

```
spec:
  fepAction:
    type: promote_standby
  targetClusterName: my-fep
```

Action type - update_multi_master_replication

The update_multi_master_replication action updates the bidirectional replication definition according to changes in the bidirectional replication definition specified in the ConfigMap referenced by the spec.fep.multiMasterReplication.configMapName field of the target FEPCluster custom resource.

Action type - fixed_stats

The fixed_stats action performs a statistics operation (pg_dbms_stats) on the target FEPCluster.

The fixed_stats action must specify the operations that can be performed by pg_dbms_stats. Specify fixedStatsType: < operation type > in spec.fepAction.args. Depending on the operation type, there are additional required and optional arguments. Refer to the table below.

Table 1.1 Operation Types and Arguments

Operation Type	Required Arguments	Optional Argument
backup	None All databases are backed up with statistics. Also, if an identifying comment is omitted, "FEPAction" is assigned as the comment.	targetDb: Target database fixedObject: Name of the object after the schema Example)Target specific columns fixedObject: myschema.mytable.myclomun comment: "XXX"
restore	targetDb: Target database backupId: Backup ID or timestamp: timestamp The data type is timestampz. The statistics are pinned using the specified backup ID or the most recent backup before the specified time.	Only when timestamp is defined can a post-schema object be specified. fixedObject: Name of the object after the schema Example)Target specific columns fiexdObject: myschema.mytable.myclomun
purge	backupId: Backup ID targetDb: Target data base Erases backups before the specified backup ID for the database specified in targetDb.	You can specify a delete flag. force: true force: false If omitted, it will be executed as false.
lock	targetDb: Target data base Fix statistics for the specified database.	fixedObject: Name of the object after the schema

Operation Type	Required Arguments	Optional Argument
		Example)Target specific columns fixedObject: myschema.mytable.myclomun
unlock	targetDb: Target data base Unpin statistics performed on the specified database.	fixedObject: Name of the object after the schema Example)Target specific columns fixedObject: myschema.mytable.myclomun
cleanup	targetDb: Target data base Performs a statistics cleanup on the specified database.	None
import	targetDb: Target data base Fixes statistics from a binary file for the database specified in targetDb. The file is imported from the fep.fixedStats.endpoint.protocol information defined in the FEPCluster custom resource. protocol changes the required arguments. See " Table 1.2 Required Arguments Per Protocol ".	fixedObject: Name of the object after the schema
export	targetDb: Target data base targetStats: Valid and regular statistics Which to export (effective or plain) Exports the currently valid or canonical statistics for the database specified in targetDb. The file export destination uses the fep.fixedStats.endpoint. protocol information defined in the FEPCluster custom resource. protocol changes the required arguments. See " Table 1.2 Required Arguments Per Protocol ".	fixedObject: Name of the object after the schema

Table 1.2 Required Arguments Per Protocol

Protocol	Required Arguments	Description
s3, gcs	url	URL of object storage
blob	azureBlobName	BLOB name of the statistics binary file
	azureContainerName	Container name of the Azure storage account
local	file	Specify the name of the file to which statistics will be exported/imported.

The following shows a specification example.

```

apiVersion: fep.fujitsu.io/v1
kind: FEPAction
metadata:
  name: fep-action-firxdStats
spec:
  fepAction:
    targetClusterName: new-fep
    type: fixed_stats
    args:
      fixedStatsType: backup
      targetDb: mydb

```

```
fixedObject: schema.table.attaname
comment: "xxyzzz"
```

1.2.11 FEPEXporter Custom Resource

Field	Default	Details
apiVersion	fep.fujitsu.io/v1	Mandatory as it is You cannot make changes after it has been created.
kind	FEPEXporter	Mandatory as it is You cannot make changes after it has been created.
metadata.name	fep-monitor	Name of FEPEXporter CR - must be unique in namespace You cannot make changes after it has been created.
metadata.namespace	fep-ns	Namespace - OCP populates it as current You cannot make changes after it has been created.
spec.prometheus		Optional Prometheus MTLs spec section
spec.prometheus.tls		
spec.prometheus.tls.certificateName		Optional This points to Kubernetes TLS secret that contains the certificate of Prometheus ServiceMonitor. FEPEXporter will use this for certificate authentication. The certificate itself is stored in the key tls.crt.
spec.prometheus.tls.caName		Optional This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt.
spec.fepExporter.		Exporter spec section
spec.fepExporter.authSecret		Optional Base Authentication secret to provide username & encrypted password of user
spec.fepExporter.authSecret.secretName		Secret name
spec.fepExporter.authSecret.usernameKey		Key of username in specified secret
spec.fepExporter.authSecret.passwordKey		Key of password in specified secret
spec.fepExporter.customLabel		Custom label to be added to Prometheus ServiceMonitor
spec.fepExporter.tls		FEPEXporter MTLs specs
spec.fepExporter.tls.certificateName		Optional This point to Kubernetes TLS secret that contains the certificate of FepExporter. Prometheus will use this for certificate authentication. The certificate itself is stored in the key tls.crt.
spec.fepExporter.tls.caName		Optional

Field	Default	Details
		This points to Kubernetes configmap that contains additional CA the client use to verify a server certificate. The CA is stored in the key ca.crt.
spec.fepExporter.option.measurement.recallForVector.enable	false	Optional true: Enables the repeatability measurement feature.
spec.fepExporter.option.measurement.recallForVector.alertThreshold	0	Optional If the recall falls below this threshold, an alert is issued to the AlertManager. The value can be between 0 and 1. If 0 is specified, no alert is created.
spec.fepExporter.disableDefaultQueries	false	Optional Not defined or set to false => Create default queries Defined and set to true => Do not create default queries.
spec.fepExporter.disableDefaultAlertRules	false	Optional Not defined or set to false => Create default alert rules Defined and set to true => Do not create default alert rules. If Default queries are disabled => Do not create default alert rule.
spec.fepExporter.exporterLogLevel	error	Set logging level: one of debug, info, warn, error
spec.fepExporter.fepClusterList		Array of FEPCluster to monitor
spec.fepExporter.image.image		quay.io/fujitsu/fujitsu-enterprise-postgres-exporter:ubi9-18-1.0 Optional If not specified; image name is picked up from operator environment variable
spec.fepExporter.image.pullPolicy	IfNotPresent	Always or IfNotPresent
spec.fepExporter.mcSpec.limits	cpu: 500m memory: 700Mi	Max CPU allocated to exporter container Max memory allocated to exporter container
spec.fepExporter.mcSpec.requests	cpu: 200m memory: 512Mi	CPU allocation at start for exporter container memory allocation at start for exporter container
spec.fepExporter.scrapeInterval	30s	Optional This parameter may be specified to change statistics scraping frequency. If specified, Prometheus will poll FEPEXporter at given interval. CHANGE THIS PARAMETER ONLY IF REALLY REQUIRED
spec.fepExporter.scrapeTimeout	30s	Optional This parameter may be specified to change statistics scraping timeout. If specified, Prometheus will wait for FEPEXporter for maximum this given period to return statistics. CHANGE THIS PARAMETER ONLY IF REALLY REQUIRED

Field	Default	Details
spec.fepExporter.sysExtraLogging	true	To turn on extra debugging messages for operator, set value to true <i>It can be turned on/off at any time</i>
spec.fepExporter.sysExtraEvent		Optional. To turn on event notification for custom resource changes, set the value to true. Can be turned on or off at any time.
spec.fepExporter.restartRequired	false	true: To restart FEPEXporter, when there is any change found in CR or FEPCluster false: Will not restart FEPEXporter
spec.fepExporter.userCustomQueries		Optional Section Example user's custom query to extract additional metrics.
spec.fepExporter.fepExporterGlobalEnvSec		Specifies the name of a Kubernetes secret that contains key/value pairs common to all containers running in the FEPEXporter definition. When FEPCluster automatically creates a FEPEXporter, it is copied from FEPCluster.
spec.fepExporter.fepExporterEnvSec		Specifies the name of the Kubernetes secret that contains key-value pairs specific to the prometheus-fep-exporter container. When FEPCluster automatically creates a FEPEXporter, it is copied from FEPCluster.

```
usr_example:
  query: "SELECT EXTRACT(EPOCH FROM (now() - pg_last_xact_replay_timestamp())) as lag"
  master: true
  metrics:
    - lag:
      usage: "GAUGE"
      description: "Replication lag behind master in seconds"
```

1.2.12 FEPAutoscale Custom Resource

When FEPClusterCR is defined, FEPAutoscaleCR is defined.

The parameters are as follows:

Configuration changes are made in FEPClusterCR.

Field	Default	Details
apiVersion	fep.fujitsu.io/v1	Fixed
kind	FEPAutoscale	Fixed
metadata.name	Same as FEPClusterCR	Fixed
metadata.namespace	Same as FEPClusterCR	Fixed
spec.scaleout.policy	off	[cpu_utilization/connection_number/off]
spec.scaleout.threshold	cpu_utilization: 40 connection_number: 40	Threshold
spec.scaleout.metricName	pg_capacity_connection_average	Specify this parameter if policy is connection_number. The custom metrics server must publish the average number of connections in the FEP cluster under this name.

Field	Default	Details
spec.scaleout.stabilizationWindowSeconds	0	If the duration (seconds) threshold of this parameter has been exceeded continuously, a scale out is performed.
spec.limits.maxReplicas	2	Maximum number of replicas (0 to 15) If the value is out of range, no automatic scale out is performed.

1.2.13 FEPUUpgrade Custom Resource

If "spec.fepChildCrVal.upgrade" is defined for the FEPCluster custom resource, the FEPUUpgrade custom resource is defined.

The parameters are as follows:

Field	Default	Details
apiVersion	fep.fujitsu.io/v1	Fixed
kind	FEPUUpgrade	Fixed
metadata.name	Same as FEPClusterCR	Fixed
metadata.namespace	Same as FEPClusterCR	Fixed
spec.upgrade		
spec.upgrade.sourceCluster		Specifies the FEPClusterCR name from which to migrate data. Required.
spec.upgrade.mcSpec.limits	cpu: 200m memory: 300Mi	Optional Specifies the maximum number of resources to allocate to the upgrade execution container.
spec.upgrade.mcSpec.requests	cpu: 100m memory: 200Mi	Optional Specifies the lower limit of resources allocated to the upgrade execution container.
spec.upgrade.image		Optional If omitted, the URL for image is obtained from the operator container environment.
spec.upgrade.imagePullPolicy	IfNotPresent	Optional Specifies the pull policy for the container image. - Always - IfNotPresent - Never
spec.upgrade.source.pgAdminTls.certificateName		Optional If you do not define spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName for the data source, it points to the Kubernetes TLS secret that contains the certificate for the Postgres user "postgres" in the data source. If the data source FEP has set the authentication method for the upgrade execution container to "cert", then the upgrade execution container uses the certificate defined as secret.

Field	Default	Details
spec.upgrade.destination.pgAdminTls.certificateName		Optional If you have not defined the spec.fepChildCrVal.sysUsers.pgAdminTls.certificateName of the newly created FEPCluster, it points to the Kubernetes TLS secret that contains the certificate of the Postgres user "postgres" in the data source. If you create a new FEP with the "cert" authentication method for the upgrade execution container, the upgrade execution container uses the certificate defined as secret.
spec.upgrade.storage		Optional Defines the storage for storing dump files.
spec.upgrade.storage.storageClass		Optional If omitted, the default storage class for your environment is used.
spec.upgrade.storage.size	2Gi	Optional Specifies the size of the storage to store the dump file.
spec.upgrade.storage.accessModes	ReadWriteOnce	Optional accessModes for store the dump file Specified as an array of accessModes e.g. [ReadWriteMany] If omitted, it will be treated as [ReadWriteOnce]

1.2.14 FEPLogging Custom Resources

The fepLogging section needs to be added under spec to define required parameters for FEPLogging configuration.

Following is a sample template :

```
spec:
  fepLogging:
    elastic:
      authSecret:
        secretName: elastic-auth
        passwordKey: password
        userKey: username
      host: elastic-passthrough.apps.openshift.com
      logstashPrefix: postgres
      port: 443
      scheme: https
      sslVerify: true
      tls:
        certificateName: elastic-cert
        caName: elastic-cacert
    image:
      pullPolicy: IfNotPresent
    mcSpec:
      limits:
        cpu: 500m
        memory: 700Mi
      requests:
        cpu: 200m
        memory: 512Mi
    restartRequired: false
```

```

sysExtraLogging: false
scrapeInterval: 30s
scrapeTimeout: 30s
tls:
  certificateName: fluentd-cert
  caName: cacert
prometheus:
  ...

```

Below is the list of all parameters defined in the fepLogging section, along with their brief description

Custom Resource spec	Required/Optional	Change Effect	Updating value allowed
spec.fepLogging.image.image	Optional	Fluentd Image of FEPLogging	Yes
spec.fepLogging.image.pullPolicy	Required	Fluentd Image pull policy of FEPLogging	Yes
spec.fepLogging.mcSpec.limits.cpu	Required	Max CPU allocated to fluentd container	Yes
spec.fepLogging.mcSpec.limits.memory	Required	Max memory allocated to fluentd container	Yes
spec.fepLogging.mcSpec.requests.cpu	Required	CPU allocation at start for fluentd container	Yes
spec.fepLogging.mcSpec.requests.memory	Required	Memory allocation at start for fluentd container	Yes
spec.fepLogging.sysExtraLogging	Required	To turn on extra debugging messages for operator, set value to true. It can be turned on/off at any time	Yes
spec.fepLogging.sysExtraEvent	Optional	To turn on event notification for changes to custom resources, set the value to true. You can turn it on or off at any time.	Yes
spec.fepLogging.restartRequired	Required	To restart FEPLogging instance for applying any new configuration for example after certificate rotation	Yes
spec.fepLogging.scrapeInterval	Optional	Scrape interval for Prometheus to fetch metrics from FEPLogging instance	Yes
spec.fepLogging.scrapeTimeout	Optional	Scrape Timeout for Prometheus to fetch metrics from FEPLogging instance	Yes
spec.fepLogging.elastic.host	Optional	Target Elasticsearch host name	Yes
spec.fepLogging.elastic.port	Optional	Target Elasticsearch port number	Yes
spec.fepLogging.elastic.authSecret.secretName	Optional	Secret name which contains Elasticsearch authentication username & password	Yes
spec.fepLogging.elastic.authSecret.userKey	Optional	Username key specified in Elasticsearch authentication secret	Yes
spec.fepLogging.elastic.authSecret.passwordKey	Optional	Password key specified in Elasticsearch authentication secret	Yes
spec.fepLogging.elastic.logstashPrefix	Optional	Logstash prefix to differentiate index pattern in elastic search. Default value is postgres	Yes
spec.fepLogging.elastic.auditLogstashPrefix	Optional	Logstash prefix to differentiate index pattern in elastic search for auditlog. Default value is postgres	Yes
spec.fepLogging.elastic.scheme	Optional	Connection scheme between FEPLogging & Elasticsearch. Possible options http & https	Yes

Custom Resource spec	Required/ Optional	Change Effect	Updating value allowed
spec.fepLogging.elastic.sslVerify	Optional	Set to true if you want to verify ssl certificate. If set to false then will not consider TLS certificate	Yes
spec.fepLogging.elastic.tls.certificateName	Optional	Kubernetes secret name which holds fluentd certificate	Yes
spec.fepLogging.elastic.tls.caName	Optional	Kubernetes configmap which holds cacert of Elasticsearch to verify Elasticsearch TLS connection	Yes
spec.fepLogging.tls.certificateName	Optional	Kubernetes secret name which holds Fluentd certificate	Yes
spec.fepLogging.tls.caName	Optional	Kubernetes configmap which holds cacert of Fluentd to configure MTLS between FEPLogging & Prometheus	Yes
spec.prometheus.tls.certificateName	Optional	Kubernetes secret name which holds Prometheus certificate	Yes
spec.prometheus.tls.caName	Optional	Kubernetes configmap which holds cacert of Fluentd to configure MTLS between FEPLogging & Prometheus	Yes

1.2.15 FEP Custom Resources - spec.fep.pgBadger

Custom Resource spec	Change Effect
pgBadger.schedules.create	The 'create' schedule to create report and upload it to endpoint
pgBadger.schedules.cleanup	The 'cleanup' schedule to delete the report left in container
pgBadger.options.incremental	Default: false; When set to true: create incremental report in pgbadger
pgBadger.endpoint.authentication	a secret to contain authentication info to access endpoint support basic auth only
pgBadger.endpoint.customCertificateName	Client certificate reference in customCertificate CR
pgBadger.endpoint.fileUploadParameter	The file upload parameter defined by the web server Default: 'file'
pgBadger.endpoint.insecure	equivalent to curl -insecure option, default to false
pgBadger.endpoint.url	Web server url to upload the report file

1.2.16 FEP Custom Resources - spec.fep.pgAuditLog

1.2.16.1 Details of pgAuditLog.endpoint.authentication

Protocol	Required key	Description
'http' or not defined	basic_auth	The basic authentication for http web server
's3'	aws_access_key	AWS access key
	aws_secret_key	AWS secret key
'blob'	azure_storage_account_name	Azure storage account name

Protocol	Required key	Description
	azure_storage_account_key	Azure storage account key

The Operator creates a default secret with keys for all the protocols with empty values when "pgAuditLog.endpoint.authentication" is not defined or empty.

The default secret is a template which the end user can update its proper values. The following is its content:

Default Authentication Secret
<pre> kind: Secret apiVersion: v1 metadata: name: [FEPCluster name]-pgauditlog-auth namespace: [FEPCluster namespace] type: Opaque data: basic_auth: "" aws_access_key: "" aws_access_secret: "" azure_storage_account_name: "" azure_storage_account_key: "" </pre>

When the default secret is created, the Operator also updates the created secret name in the FEPCluster CR:

FEPCluster
<pre> spec.fep pgAuditLog: enable: 'true' endpoint: protocol: 's3' authentication: '[FEPCluster name]-pgauditlog-auth' ... </pre>

The Operator uses the default secret but the upload feature will fail as the secret does not contain correct values. So the end user needs to update the values of the default secret to use upload feature properly.

 **Note**

- The Operator does not own - user specified secret because it is created by the end user. Only the default secret created by operator is owned by the cluster.
- When the FEPCluster has been delete, this secret will remain.

1.2.16.2 CR example for customized pgaudit ConfigMap

- Enable pgAudit
 - The pgAudit extension will be enabled.
- Use custom pgAudit config file
 - The pgAudit log will be output based on custom configuration

FEPCluster
<pre> spec.fep pgAuditLog: </pre>

FEPCluster
<pre>enable: 'true' config: my-pgaudit-conf endpoint: # fepChildCrVal.customPgAudit will be ignored in this case</pre>

ConfigMap - Name: my-pgaudit-conf
<pre>data: pgaudit.conf: [output] logger = 'auditlog' log_directory = '/database/log/audit' [rule] audit_role='jason' database='demo' class='READ, WRITE' [option]</pre>

1.2.16.3 CR example when uploading logs to Azure Blob

Use Azure blob as an endpoint to upload pgAudit file

FEPCluster (using Azure blob as endpoint)
<pre>spec.fep pgAuditLog: enable: 'true' endpoint: protocol: 'blob' authentication: my-azure-blob-secret azureContainerName: cluster1 azureBlobName: pgaudit-log-1 schedules: upload: '30 * * * *'</pre>

Secret - Name: my-azure-blob-secret
<pre>data: azure_storage_account_name: cG9zdGdyZXM= azure_storage_account_key: ZnNcG9zdGads3cGzdGdyZXMyZXNlcA==</pre>

1.2.16.4 CR example for uploading logs to S3

Use AWS S3 as an endpoint to upload pgAudit file

- The pgAudit log will be uploaded to AWS s3 storage based on the provided schedule.

FEPCluster (using S3 as endpoint)
<pre>spec.fep pgAuditLog: enable: 'true' endpoint: url: 's3://pgaudit1/cluster1' protocol: 's3' authentication: my-aws-s3-secret schedules: upload: '30 * * * *'</pre>

Secret - Name: my-aws-s3-secret

data:

aws_access_key: cG9zdGdyZXM=

aws_access_secret: ZnNlcaAZnNlcA3A==

Appendix A Default Metrics Queries

```
pg_capacity_connection:
  query: |
    select sys, idle, idleintx, idleintxl0min, idleintxlhour, idleintxlday, idleintxlweek,
    (curr.idle + curr.idleintx + curr.active) total, s.setting "max" from
    (
      select
        count(CASE WHEN a.state is null THEN 1 END) sys,
        count(CASE WHEN a.state='idle' THEN 1 END) idle,
        count(CASE WHEN a.state='idle in transaction' OR a.state='idle in transaction (aborted)' THEN
1 END) idleintx,
        count(CASE WHEN (a.state='idle in transaction' OR a.state='idle in transaction (aborted)') AND
age(now(), state_change) > interval '10 min' THEN 1 END) idleintxl0min,
        count(CASE WHEN (a.state='idle in transaction' OR a.state='idle in transaction (aborted)') AND
age(now(),state_change) > interval '1 hour' THEN 1 END) idleintxlhour,
        count(CASE WHEN (a.state='idle in transaction' OR a.state='idle in transaction (aborted)') AND
age(now(),state_change) > interval '1 day' THEN 1 END) idleintxlday,
        count(CASE WHEN (a.state='idle in transaction' OR a.state='idle in transaction (aborted)') AND
age(now(),state_change) > interval '1 week' THEN 1 END) idleintxlweek,
        count(CASE WHEN a.state='active' THEN 1 END) active
      from pg_stat_activity a
    ) curr, pg_settings s where name = 'max_connections'
  master: true
  metrics:
    - sys:
      usage: 'GAUGE'
      description: 'Number of system connections.'
    - idle:
      usage: 'GAUGE'
      description: 'Number of idle connections.'
    - idleintx:
      usage: 'GAUGE'
      description: 'Number of idle in transaction connections.'
    - idleintxl0min:
      usage: 'GAUGE'
      description: 'Number of idle in transaction connections running longer than 10 min.'
    - idleintxlhour:
      usage: 'GAUGE'
      description: 'Number of idle in transaction connections running longer than 1 hour.'
    - idleintxlday:
      usage: 'GAUGE'
      description: 'Number of idle in transaction connections running longer than 1 day.'
    - idleintxlweek:
      usage: 'GAUGE'
      description: 'Number of idle in transaction connections running longer than 1 week.'
    - total:
      usage: 'GAUGE'
      description: 'Number of total connections.'
    - max:
      usage: 'GAUGE'
      description: 'Max number of connections.'

pg_capacity_schema:
  query: |
    SELECT current_database() AS database_name, table_schema,
    COALESCE(SUM(pg_total_relation_size(''||table_schema||'.'.||table_name||''')), 0) AS size
    FROM information_schema.tables GROUP BY table_schema
  master: true
  metrics:
    - database_name:
      usage: 'LABEL'
```

```

        description: 'Database name.'
- table_schema:
    usage: 'LABEL'
    description: 'Table schema name.'
- size:
    usage: 'GAUGE'
    description: 'Disk space of schema.'

pg_capacity_tblspace:
query: |
    SELECT pg_tablespace.spcname AS tablespace_name, pg_tablespace_size(pg_tablespace.spcname) AS
tablespace_size FROM pg_tablespace
master: true
metrics:
- tablespace_name:
    usage: 'LABEL'
    description: 'Table space name.'
- tablespace_size:
    usage: 'GAUGE'
    description: 'Disk space of table space.'

pg_capacity_tblvacuum:
query: |
    SELECT current_database() datname, t.table_schema, count(t.table_name) table_count
    FROM information_schema.tables t
    INNER JOIN pg_catalog.pg_stat_user_tables tu on t.table_schema::text=tu.schemaname::text and
t.table_name::text=tu.relname::text
    and
    age(now(),greatest(COALESCE(last_vacuum, '1970-01-01Z'), COALESCE(last_autovacuum,
'1970-01-01Z'))) > interval '1 day'
    GROUP BY t.table_schema
master: true
metrics:
- datname:
    usage: 'LABEL'
    description: 'Database name.'
- table_schema:
    usage: 'LABEL'
    description: 'Table schema name.'
- table_count:
    usage: 'GAUGE'
    description: 'Number of tables without vacuum for more than a day.'

pg_capacity_longtx:
query: |
    with xact_count as (
    SELECT COALESCE(datname, '') datname, count(1)
    FROM pg_stat_activity
    where backend_type='client backend' and age(now(), COALESCE(xact_start, '1970-01-01Z')) >
interval '5 minutes'
    group by datname
    )
    select d.datname, coalesce(xc.count, 0) as count from pg_database d left join xact_count xc on
d.datname=xc.datname
master: true
metrics:
- datname:
    usage: 'LABEL'
    description: 'Database name.'
- count:
    usage: 'GAUGE'
    description: 'Number of transactions running longer than 5 minutes.'

```

```

pg_capacity_tblbloat:
query: |
    SELECT DISTINCT
        current_database() as datname, schemaname, tablename as relname, /*reltuples::bigint,
relpages::bigint, otta,*/
        CASE WHEN relpages < otta THEN 0 ELSE bs*(sml.relpages-otta)::BIGINT END AS wastedbytes
    FROM (
        SELECT
            schemaname, tablename, cc.reltuples, cc.relpages, bs,
            CEIL((cc.reltuples*((datahdr+ma-
                (CASE WHEN datahdr%ma=0 THEN ma ELSE datahdr%ma END))+nullhdr2+4))/(bs-20::float)) AS otta,
            COALESCE(c2.relname,'?') AS iname, COALESCE(c2.reltuples,0) AS ituples, COALESCE(c2.relpages,
0) AS ipages,
            COALESCE(CEIL((c2.reltuples*(datahdr-12))/(bs-20::float)),0) AS iotta -- very rough
approximation, assumes all cols

        FROM (
            SELECT
                ma,bs,schemaname,tablename,
                (datawidth+(hdr+ma-(case when hdr%ma=0 THEN ma ELSE hdr%ma END))):numeric AS datahdr,
                (maxfracsum*(nullhdr+ma-(case when nullhdr%ma=0 THEN ma ELSE nullhdr%ma END))) AS nullhdr2
            FROM (
                SELECT
                    schemaname, tablename, hdr, ma, bs,
                    SUM((1-null_frac)*avg_width) AS datawidth,
                    MAX(null_frac) AS maxfracsum,
                    hdr+(
                        SELECT 1+count(*)/8
                        FROM pg_stats s2
                        WHERE null_frac<>0 AND s2.schemaname = s.schemaname AND s2.tablename = s.tablename
                    ) AS nullhdr
                FROM pg_stats s, (
                    SELECT
                        (SELECT current_setting('block_size')::numeric) AS bs,
                        CASE WHEN substring(v,12,3) IN ('8.0','8.1','8.2') THEN 27 ELSE 23 END AS hdr,
                        CASE WHEN v ~ 'mingw32' THEN 8 ELSE 4 END AS ma
                        FROM (SELECT version() AS v) AS foo
                    ) AS constants
                GROUP BY 1,2,3,4,5
            ) AS foo
        ) AS rs
        JOIN pg_class cc ON cc.relname = rs.tablename
        JOIN pg_namespace nn ON cc.relnamespace = nn.oid AND nn.nspname = rs.schemaname AND nn.nspname
<> 'information_schema'
        LEFT JOIN pg_index i ON indrelid = cc.oid
        LEFT JOIN pg_class c2 ON c2.oid = i.indexrelid
    ) AS sml
    ORDER BY wastedbytes DESC
master: true
metrics:
- datname:
    usage: 'LABEL'
    description: 'Database name.'
- schemaname:
    usage: 'LABEL'
    description: 'Schema name.'
- relname:
    usage: 'LABEL'
    description: 'Name of this table.'
- wastedbytes:
    usage: 'GAUGE'
    description: 'Number of bytes wasted for table.'

```

pg_performance_locking_detail:

```
query: |
    SELECT blocked_locks.pid AS blocked_pid,
           blocked_activity.username AS blocked_user,
           blocking_locks.pid AS blocking_pid,
           blocking_activity.username AS blocking_user,
           blocked_activity.query AS blocked_statement,
           1 locks
    FROM pg_catalog.pg_locks blocked_locks
    JOIN pg_catalog.pg_stat_activity blocked_activity ON blocked_activity.pid = blocked_locks.pid
    JOIN pg_catalog.pg_locks blocking_locks
    ON blocking_locks.locktype = blocked_locks.locktype
    AND blocking_locks.DATABASE IS NOT DISTINCT FROM blocked_locks.DATABASE
    AND blocking_locks.relation IS NOT DISTINCT FROM blocked_locks.relation
    AND blocking_locks.page IS NOT DISTINCT FROM blocked_locks.page
    AND blocking_locks.tuple IS NOT DISTINCT FROM blocked_locks.tuple
    AND blocking_locks.virtualxid IS NOT DISTINCT FROM blocked_locks.virtualxid
    AND blocking_locks.transactionid IS NOT DISTINCT FROM blocked_locks.transactionid
    AND blocking_locks.classid IS NOT DISTINCT FROM blocked_locks.classid
    AND blocking_locks.objid IS NOT DISTINCT FROM blocked_locks.objid
    AND blocking_locks.objsubid IS NOT DISTINCT FROM blocked_locks.objsubid
    AND blocking_locks.pid != blocked_locks.pid
    JOIN pg_catalog.pg_stat_activity blocking_activity ON blocking_activity.pid = blocking_locks.pid
    WHERE NOT blocked_locks.GRANTED
master: true
metrics:
  - blocked_pid:
      usage: 'LABEL'
      description: 'Blocked process id.'
  - blocked_user:
      usage: 'LABEL'
      description: 'Blocked user.'
  - blocking_pid:
      usage: 'LABEL'
      description: 'Blocking process id.'
  - blocking_user:
      usage: 'LABEL'
      description: 'Blocking user.'
  - blocked_statement:
      usage: 'LABEL'
      description: 'Blocked statement.'
  - locks:
      usage: 'GAUGE'
      description: 'Number of processes in blocked state.'
```

pg_performance_locking:

```
query: |
    WITH
    locks as (
        SELECT blocked_locks.DATABASE, count(blocked_locks.pid) locks
        FROM pg_catalog.pg_locks blocked_locks
        JOIN pg_catalog.pg_stat_activity blocked_activity ON blocked_activity.pid = blocked_locks.pid
        JOIN pg_catalog.pg_locks blocking_locks
        ON blocking_locks.locktype = blocked_locks.locktype
        AND blocking_locks.DATABASE IS NOT DISTINCT FROM blocked_locks.DATABASE
        AND blocking_locks.relation IS NOT DISTINCT FROM blocked_locks.relation
        AND blocking_locks.page IS NOT DISTINCT FROM blocked_locks.page
        AND blocking_locks.tuple IS NOT DISTINCT FROM blocked_locks.tuple
        AND blocking_locks.virtualxid IS NOT DISTINCT FROM blocked_locks.virtualxid
        AND blocking_locks.transactionid IS NOT DISTINCT FROM blocked_locks.transactionid
        AND blocking_locks.classid IS NOT DISTINCT FROM blocked_locks.classid
        AND blocking_locks.objid IS NOT DISTINCT FROM blocked_locks.objid
        AND blocking_locks.objsubid IS NOT DISTINCT FROM blocked_locks.objsubid
```

```

        AND blocking_locks.pid != blocked_locks.pid
        JOIN pg_catalog.pg_stat_activity blocking_activity ON blocking_activity.pid =
blocking_locks.pid
        WHERE NOT blocked_locks.GRANTED group by blocked_locks.DATABASE
    ),
    dbs as (
        select * from pg_catalog.pg_database
    )
    select dbs.datname, coalesce(locks.locks, 0) locks from dbs left join locks on dbs.oid=DATABASE
master: true
metrics:
  - datname:
      usage: 'LABEL'
      description: 'Database name'
  - locks:
      usage: 'GAUGE'
      description: 'Number of processes in blocked state.'

pg_replication:
  query: |
    SELECT CASE WHEN pg_last_wal_receive_lsn() = pg_last_wal_replay_lsn() THEN 0 ELSE GREATEST (0,
EXTRACT(EPOCH FROM (now() - pg_last_xact_replay_timestamp()))) END AS lag
  master: true
  metrics:
    - lag:
        usage: "GAUGE"
        description: "Replication lag behind master in seconds"

pg_postmaster:
  query: |

    SELECT pg_postmaster_start_time as start_time_seconds from pg_postmaster_start_time()
  master: true
  metrics:
    - start_time_seconds:
        usage: "GAUGE"
        description: "Time at which postmaster started"

pg_stat_user_tables:
  query: |
    SELECT
      current_database() datname,
      schemaname,
      relname,
      seq_scan,
      seq_tup_read,
      idx_scan,
      idx_tup_fetch,
      n_tup_ins,
      n_tup_upd,
      n_tup_del,
      n_tup_hot_upd,
      n_live_tup,
      n_dead_tup,
      n_mod_since_analyze,
      last_vacuum,
      last_autovacuum,
      last_analyze,
      last_autoanalyze,
      vacuum_count,
      autovacuum_count,
      analyze_count,
      autoanalyze_count

```

```

FROM
  pg_stat_user_tables
master: true
metrics:
  - datname:
      usage: "LABEL"
      description: "Name of current database"
  - schemaname:
      usage: "LABEL"
      description: "Name of the schema that this table is in"
  - relname:
      usage: "LABEL"
      description: "Name of this table"
  - seq_scan:
      usage: "COUNTER"
      description: "Number of sequential scans initiated on this table"
  - seq_tup_read:
      usage: "COUNTER"
      description: "Number of live rows fetched by sequential scans"
  - idx_scan:
      usage: "COUNTER"
      description: "Number of index scans initiated on this table"
  - idx_tup_fetch:
      usage: "COUNTER"
      description: "Number of live rows fetched by index scans"
  - n_tup_ins:
      usage: "COUNTER"
      description: "Number of rows inserted"
  - n_tup_upd:
      usage: "COUNTER"
      description: "Number of rows updated"
  - n_tup_del:
      usage: "COUNTER"
      description: "Number of rows deleted"
  - n_tup_hot_upd:
      usage: "COUNTER"
      description: "Number of rows HOT updated (i.e., with no separate index update required)"
  - n_live_tup:
      usage: "GAUGE"
      description: "Estimated number of live rows"
  - n_dead_tup:
      usage: "GAUGE"
      description: "Estimated number of dead rows"
  - n_mod_since_analyze:
      usage: "GAUGE"
      description: "Estimated number of rows changed since last analyze"
  - last_vacuum:
      usage: "GAUGE"
      description: "Last time at which this table was manually vacuumed (not counting VACUUM FULL)"
  - last_autovacuum:
      usage: "GAUGE"
      description: "Last time at which this table was vacuumed by the autovacuum daemon"
  - last_analyze:
      usage: "GAUGE"
      description: "Last time at which this table was manually analyzed"
  - last_autoanalyze:
      usage: "GAUGE"
      description: "Last time at which this table was analyzed by the autovacuum daemon"
  - vacuum_count:
      usage: "COUNTER"
      description: "Number of times this table has been manually vacuumed (not counting VACUUM
FULL)"
  - autovacuum_count:

```

```

        usage: "COUNTER"
        description: "Number of times this table has been vacuumed by the autovacuum daemon"
    - analyze_count:
        usage: "COUNTER"
        description: "Number of times this table has been manually analyzed"
    - autoanalyze_count:
        usage: "COUNTER"
        description: "Number of times this table has been analyzed by the autovacuum daemon"

pg_statio_user_tables:
    query: |
        SELECT current_database() datname, schemaname, relname, heap_blks_read, heap_blks_hit,
idx_blks_read, idx_blks_hit, toast_blks_read, toast_blks_hit, tidx_blks_read, tidx_blks_hit FROM
pg_statio_user_tables
    metrics:
    - datname:
        usage: "LABEL"
        description: "Name of current database"
    - schemaname:
        usage: "LABEL"
        description: "Name of the schema that this table is in"
    - relname:
        usage: "LABEL"
        description: "Name of this table"
    - heap_blks_read:
        usage: "COUNTER"
        description: "Number of disk blocks read from this table"
    - heap_blks_hit:
        usage: "COUNTER"
        description: "Number of buffer hits in this table"
    - idx_blks_read:
        usage: "COUNTER"
        description: "Number of disk blocks read from all indexes on this table"
    - idx_blks_hit:
        usage: "COUNTER"
        description: "Number of buffer hits in all indexes on this table"
    - toast_blks_read:
        usage: "COUNTER"
        description: "Number of disk blocks read from this table's TOAST table (if any)"
    - toast_blks_hit:
        usage: "COUNTER"
        description: "Number of buffer hits in this table's TOAST table (if any)"
    - tidx_blks_read:
        usage: "COUNTER"
        description: "Number of disk blocks read from this table's TOAST table indexes (if any)"
    - tidx_blks_hit:
        usage: "COUNTER"
        description: "Number of buffer hits in this table's TOAST table indexes (if any)"

pg_database:
    query: |

        SELECT pg_database.datname, pg_database_size(pg_database.datname) as size_bytes FROM pg_database
master: true
cache_seconds: 30
    metrics:
    - datname:
        usage: "LABEL"
        description: "Name of the database"
    - size_bytes:
        usage: "GAUGE"
        description: "Disk space used by the database"

```

```

pg_stat_statements:
  query: |
    SELECT t2.rolname, t3.datname, queryid, calls, total_plan_time / 1000 as
total_plan_time_seconds, total_exec_time / 1000 as total_exec_time_seconds, min_plan_time / 1000 as
min_plan_time_seconds, min_exec_time / 1000 as min_exec_time_seconds, max_plan_time / 1000 as
max_plan_time_seconds, max_exec_time / 1000 as max_exec_time_seconds, mean_plan_time / 1000 as
mean_plan_time_seconds, mean_exec_time / 1000 as mean_exec_time_seconds, stddev_plan_time / 1000 as
stddev_plan_time_seconds, stddev_exec_time / 1000 as stddev_exec_time_seconds, rows, shared_blks_hit,
shared_blks_read, shared_blks_dirtied, shared_blks_written, local_blks_hit, local_blks_read,
local_blks_dirtied, local_blks_written, temp_blks_read, temp_blks_written, blk_read_time / 1000 as
blk_read_time_seconds, blk_write_time / 1000 as blk_write_time_seconds FROM pg_stat_statements t1
JOIN pg_roles t2 ON (t1.userid=t2.oid) JOIN pg_database t3 ON (t1.dbid=t3.oid) WHERE t2.rolname !=
'rdsadmin'
  master: true
  metrics:
    - rolname:
      usage: "LABEL"
      description: "Name of user"
    - datname:
      usage: "LABEL"
      description: "Name of database"
    - queryid:
      usage: "LABEL"
      description: "Query ID"
    - calls:
      usage: "COUNTER"
      description: "Number of times executed"
    - total_plan_time_seconds:
      usage: "COUNTER"
      description: "Total plan time spent in the statement, in milliseconds"
    - total_exec_time_seconds:
      usage: "COUNTER"
      description: "Total exec time spent in the statement, in milliseconds"
    - min_plan_time_seconds:
      usage: "GAUGE"
      description: "Minimum plan time spent in the statement, in milliseconds"
    - min_exec_time_seconds:
      usage: "GAUGE"
      description: "Minimum exec time spent in the statement, in milliseconds"
    - max_plan_time_seconds:
      usage: "GAUGE"
      description: "Maximum plan time spent in the statement, in milliseconds"
    - max_exec_time_seconds:
      usage: "GAUGE"
      description: "Maximum exec time spent in the statement, in milliseconds"
    - mean_plan_time_seconds:
      usage: "GAUGE"
      description: "Mean plan time spent in the statement, in milliseconds"
    - mean_exec_time_seconds:
      usage: "GAUGE"
      description: "Mean exec time spent in the statement, in milliseconds"
    - stddev_plan_time_seconds:
      usage: "GAUGE"
      description: "Population standard deviation of plan time spent in the statement, in
milliseconds"
    - stddev_exec_time_seconds:
      usage: "GAUGE"
      description: "Population standard deviation of exec time spent in the statement, in
milliseconds"
    - rows:
      usage: "COUNTER"
      description: "Total number of rows retrieved or affected by the statement"
    - shared_blks_hit:

```

```

        usage: "COUNTER"
        description: "Total number of shared block cache hits by the statement"
- shared_blks_read:
        usage: "COUNTER"
        description: "Total number of shared blocks read by the statement"
- shared_blks_dirtied:
        usage: "COUNTER"
        description: "Total number of shared blocks dirtied by the statement"
- shared_blks_written:
        usage: "COUNTER"
        description: "Total number of shared blocks written by the statement"
- local_blks_hit:
        usage: "COUNTER"
        description: "Total number of local block cache hits by the statement"
- local_blks_read:
        usage: "COUNTER"
        description: "Total number of local blocks read by the statement"
- local_blks_dirtied:
        usage: "COUNTER"
        description: "Total number of local blocks dirtied by the statement"
- local_blks_written:
        usage: "COUNTER"
        description: "Total number of local blocks written by the statement"
- temp_blks_read:
        usage: "COUNTER"
        description: "Total number of temp blocks read by the statement"
- temp_blks_written:
        usage: "COUNTER"
        description: "Total number of temp blocks written by the statement"
- blk_read_time_seconds:
        usage: "COUNTER"
        description: "Total time the statement spent reading blocks, in milliseconds (if
track_io_timing is enabled, otherwise zero)"
- blk_write_time_seconds:
        usage: "COUNTER"
        description: "Total time the statement spent writing blocks, in milliseconds (if
track_io_timing is enabled, otherwise zero)"

```

```
pg_password_valid:
```

```

query: |
    SELECT
        rolname,
        TRUNC (EXTRACT (EPOCH FROM (rolvaliduntil - now())) / (60*60*24)) AS days,
        EXTRACT (EPOCH FROM (rolvaliduntil - now())) AS seconds,
        cast(rolvaliduntil AS TEXT) AS date
    FROM
        pg_roles
    WHERE
        rolvaliduntil!='infinity' AND rolvaliduntil is not null

```

```
master: true
```

```
metrics:
```

```

- rolname:
        usage: "LABEL"
        description: "Name of user"
- date:
        usage: "LABEL"
        description: "Password Expiration Date"
- days:
        usage: "GAUGE"
        description: "Number of days remaining before password expires."
- seconds:
        usage: "GAUGE"
        description: "Number of seconds remaining before password expires."

```

```

pg_not_set_password_valid:
query: |
SELECT
COUNT(CASE WHEN a.rolvaliduntil is null AND a.rolcanlogin='t' THEN 1 END) null_count,
COUNT(CASE WHEN a.rolvaliduntil='infinity' AND a.rolcanlogin='t' THEN 1 END) infinity_count,
COUNT(CASE WHEN (a.rolvaliduntil is null OR a.rolvaliduntil='infinity') AND a.rolcanlogin='t'
THEN 1 END) all_count
FROM pg_roles a
master: true
metrics:
- null_count:
usage: "GAUGE"
description: "Number of days remaining before password valid is null."
- infinity_count:
usage: "GAUGE"
description: "Number of days remaining before password valid is infinity."
- all_count:
usage: "GAUGE"
description: "Number of days remaining before password valid is null or infinity."

pg_tde_encrypted:
query: |
SELECT
current_database() datname,
ts.oid AS tablespace_oid,
ts.spcname AS tablespace_name,
tsx.spcencalgo AS encryption_algorithm,
coalesce(t.count, 0) AS objs
FROM
pg_tablespace ts
JOIN pgx_tablespaces tsx ON ts.oid = tsx.spctablespace
LEFT OUTER JOIN (
SELECT
CASE WHEN c.reltablespace <> 0
THEN c.reltablespace
ELSE (select dattablespace from pg_database where datname = current_database())
END AS reltablespaceid,
count(*) AS count
FROM pg_class c
LEFT JOIN pg_namespace n ON n.oid = c.relnamespace
WHERE c.relkind = ANY (ARRAY['r'::"char", 'm'::"char", 'p'::"char", 'i'::"char"])
AND (n.nspname <> ALL (ARRAY['pg_toast'::name, 'pg_catalog'::name,
'information_schema'::name]))
GROUP BY c.reltablespace
) t ON t.reltablespaceid = ts.oid
metrics:
- datname:
usage: 'LABEL'
description: "Database name."
- tablespace_oid:
usage: 'LABEL'
description: "oid of the tablespace to check."
- tablespace_name:
usage: 'LABEL'
description: "Name of the tablespace to check."
- encryption_algorithm:
usage: 'LABEL'
description: "Algorithm used for encryption."
- objs:
usage: 'GAUGE'
description: "Number of tables and indexes in the tablespace."

```

```

pg_user_profile:
  query: |
    SELECT
      COUNT(*) AS total_roles,
      SUM(CASE WHEN userprfpasswordstatus = 'o' AND userprfaccountlock = 0 THEN 1 ELSE 0 END) AS
valid_roles,
      SUM(CASE WHEN userprfpasswordstatus = 'g' AND userprfaccountlock = 0 THEN 1 ELSE 0 END) AS
grace_time_roles,
      SUM(CASE WHEN userprfpasswordstatus = 'e' AND userprfaccountlock = 0 THEN 1 ELSE 0 END) AS
expired_roles,
      SUM(CASE WHEN userprfpasswordstatus = 'o' AND userprfaccountlock IN (1, 2) THEN 1 ELSE 0 END)
AS locked_roles
    FROM pgx_user_profile;
  metrics:
    - total_roles:
      usage: "GAUGE"
      description: "number of roles"
    - valid_roles:
      usage: "GAUGE"
      description: "number of valid roles"
    - grace_time_roles:
      usage: "GAUGE"
      description: "number of grace time roles"
    - expired_roles:
      usage: "GAUGE"
      description: "number of expired roles"
    - locked_roles:
      usage: "GAUGE"
      description: "number of locked roles"

pg_txid:
  query: |
    SELECT max(age(datfrozenxid)) AS usage from pg_database where datallowconn = true
  metrics:
    - usage:
      usage: 'GAUGE'
      description: 'Cumulative number of transaction ID'

```

Appendix B Default Alert Rules

```
apiVersion: monitoring.coreos.com/v1
kind: PrometheusRule
metadata:
  name: {{ ansible_operator_meta.name }}-{{ item.name }}-alertrules
  namespace: {{ ansible_operator_meta.namespace }}
  labels:
    app: prometheus-postgres-exporter-alertrules
    name: {{ ansible_operator_meta.name }}-{{ item.name }}-alertrules
spec:
  groups:
    - name: fep-container
      rules:
        - alert: ContainerDisappeared
          annotations:
            description: {{ 'Container {{$labels.container}}/{{$labels.pod}} from
            {{$labels.namespace}} has been disappeared' }}
            summary: Container Pod disappeared.
          expr: time() -
            container_last_seen{ container="fep-patroni",
            namespace="{{ ansible_operator_meta.namespace }}", pod=~"^{{ item.name }}-sts-.*" } > 60
          labels:
            severity: warning
        - alert: ContainerHighCPUUsage
          annotations:
            description: {{ 'Container {{$labels.container}}/{{$labels.pod}} from
            {{$labels.namespace}} has been high on CPU usage(>80%) for 5 mins' }}
            summary: High Container CPU usage.
          expr:
            (sum(node_namespace_pod_container:container_cpu_usage_seconds_total:sum_rate{pod=~"{{ item.name }}-
            sts.*", namespace="{{ ansible_operator_meta.namespace }}", container="fep-patroni"}) by
            (pod,namespace,container)/sum(kube_pod_container_resource_limits_cpu_cores) by
            (pod,namespace,container))*100 > 80
          for: 5m
          labels:
            severity: warning
        - alert: ContainerHighRAMUsage
          annotations:
            description: {{ 'Container {{$labels.container}}/{{$labels.pod}} from
            {{$labels.namespace}} has been high on RAM usage(>80%) since 30 mins' }}
            summary: High container memory usage.
          expr: sum(container_memory_working_set_bytes{pod=~"{{ item.name }}-sts.*",
            namespace="{{ ansible_operator_meta.namespace }}", container="fep-patroni" } /
            container_spec_memory_limit_bytes * 100) by (pod, container, instance) > 80
          for: 30m
          labels:
            severity: warning
        - alert: PVCLowDiskSpace
          annotations:
            description: {{ 'Found low disk space on {{$labels.persistentvolumeclaim}} in
            {{$labels.namespace}} namespace.' }}
            summary: {{ 'Found low disk space on {{$labels.persistentvolumeclaim}} in
            {{$labels.namespace}} namespace.' }}
          expr:
            kubelet_volume_stats_available_bytes{namespace="{{ ansible_operator_meta.namespace }}",
            persistentvolumeclaim=~"fep.*{{ item.name }}.*"} / (kubelet_volume_stats_capacity_bytes) * 100 < 10
          for: 5m
          labels:
            severity: warning
    - name: postgres
      rules:
```

```

- alert: PostgresqlDown
  annotations:
    description: "Postgresql one or more instances are down in FEPCluster {{ item.name }} in
  namespace. Please check the FEP pods in this cluster"
    summary: "Postgresql FEPCluster {{ item.name }} in namespace is degraded"
    expr: count(pg_static{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{item.name}}-sts.*" }) <
  {{item.instances | length}}
    labels:
      severity: error
- alert: PostgresqlTooManyConnections
  annotations:
    description: {{ 'PostgreSQL instance has too many connections on server
  {{ $labels.server }} in {{ $labels.namespace }} namespace.' }}
    summary: {{ 'Postgresql too many connections (FEPCluster server {{ $labels.server }})' }}
    expr: pg_capacity_connection_total{namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*"}/
  pg_settings_max_connections > 0.9
    labels:
      severity: warning
- alert: PostgresqlRolePasswordCloseExpierd
  annotations:
    description: "The Postgresql role's password expires in less than 7 days. Please update
  the password."
    summary: "Postgresql Role Password expires in less than 7 days."
    expr: count(pg_password_valid_days{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*", rolname=~".*"
  < 8) > 0
    labels:
      severity: warning
- alert: PostgresqlRolePasswordExpired
  annotations:
    description: "The Postgresql role's password has already expired. Please update the
  password."
    summary: "Postgresql Role Password has already expired. "
    expr: count(pg_password_valid_seconds{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*", rolname=~".*"
  < 0) > 0
    labels:
      severity: warning
- alert: PasswordIsGraceTimeByUserProfile
  annotations:
    description: The password for the role in the grace time exists. Please change your password.
    summary: There is a password in the grace time
    expr: grace_time_roles{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*" } > 0
    labels:
      severity: warning
- alert: PasswordExpiredByUserProfile
  annotations:
    description: Expired role password exists. Please change your password.
    summary: Expired role password exists
    expr: expired_roles{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*" } > 0
    labels:
      severity: warning
- alert: PasswordLockedByUserProfile
  annotations:
    description: There is a role with a password lock. Please confirm the role.
    summary: Password locked role exists
    expr: locked_roles{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*" } > 0

```

```
    labels:
      severity: warning
- alert: PostgreSQLTooManyTxidUsage
  annotations:
    description: "Transaction ID usage has exceeded the value of autovacuum_freeze_max_age for
more than 24 hours. Consider periodic aggressive vacuuming."
    summary: "Transaction ID usage exceeds autovacuum_freeze_max_age"
    expr: pg_txid_usage{ namespace="{{ ansible_operator_meta.namespace }}",
service="{{ ansible_operator_meta.name }}-service", server=~"{{ item.name }}-sts.*" } >
pg_settings_autovacuum_freeze_max_age
for: 24h
    labels:
      severity: warning
```

Appendix C Operator Operation Event Notification

C.1 FEPCluster Event Notification on Custom Resource Changes

When "spec.fep.sysExtraEvent" is true, event notification of operator actions occurs when you change the value of the following fields defined in the FEPCluster custom resource.

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.fep.image.image	Start Change	FEPCluster	Started patching fep-patroni spec.fep.image.image
	Change Successful	FEPCluster	Successfully patching fep-patroni spec.fep.image.image
	Change Failed	FEPCluster	Error/Failure in patching fep-patroni spec.fep.image.image
	FEPAction Successfully Inherits Action to Custom Resource	FEPCluster	Successfully creating FEPActionCR for restart so check FEPAction result
	Fail to inherit processing to FEPAction custom resource	FEPCluster	Error/Failure in creating FEPActionCR for restart
	Start Reflection	FEPAction	Started restart Action for ALL Pods
	reflection success	FEPAction	Successfully Restart Action for ALL Pods
	Reflection failed	FEPAction	Error/Failure Restart Action for ALL Pods
spec.fep.mcSpec	Start Change	FEPCluster	Started patching fep-patroni spec.fep.mcSpec
	Change Successful	FEPCluster	Successfully patching fep-patroni spec.fep.mcSpec
	Change Failed	FEPCluster	Error/Failure in patching fep-patroni spec.fep.mcSpec
	FEPAction Successfully Inherits Action to Custom Resource	FEPCluster	Successfully creating FEPActionCR for restart so check FEPAction result
	Fail to inherit processing to FEPAction custom resource	FEPCluster	Error/Failure in creating FEPActionCR for restart
	Start Reflection	FEPAction	Started restart Action for ALL Pods
	1.2.14reflection success	FEPAction	Successfully Restart Action for ALL Pods
	Reflection failed	FEPAction	Error/Failure Restart Action for ALL Pods
spec.fep.instances (Scale in)	Start Change	FEPCluster	Started scale in FEP Cluster
	Change Successful	FEPCluster	Successfully scale in FEP Cluster
	Change Failed	FEPCluster	Error/Failure in scale in FEP Cluster
spec.fep.instances (Scale out)	Start Change	FEPCluster	Started scale out FEP Cluster
	Change Successful	FEPCluster	Successfully scale out FEP Cluster

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
	Change Failed	FEPCluster	Error/Failure in scale out FEP Cluster
spec.fep.pgBadger	Start Change	FEPCluster	Started update FEPCluster CR
	Succeeded in inheriting processing to FEPCluster custom resource	FEPCluster	Successfully updateing FEPCluster CR with current values
	Fail to inherit processing to FEPCluster custom resource	FEPCluster	Error/Failure in updateing FEPCluster CR with current values
	Start Reflection	FEPCluster	Started patching spec.fep.pgBadger
	reflection success	FEPCluster	Successfully patching spec.fep.pgAuditLog and spec.fep.pgBadger
	Reflection failed	FEPCluster	Error/Failure in patching spec.fep.pgAuditLog and spec.fep.pgBadger
spec.fep.pgBadger.schedule.create	reflection success	FEPCluster	Successfully updating spec.fep.pgBadger.schedules.create
	Reflection failed	FEPCluster	Error/Failure in updating spec.fep.pgBadger.schedules.create
spec.fep.pgBadger.schedule.cleanup	reflection success	FEPCluster	Successfully updating spec.fep.pgBadger.schedules.cleanup
	Reflection failed	FEPCluster	Error/Failure in updating spec.fep.pgBadger.schedules.cleanup
spec.fep.replicationSlots	Start Change	FEPCluster	Started update FEPCluster CR
	Succeeded in inheriting processing to FEPCluster custom resource	FEPCluster	Successfully updateing FEPCluster CR with current values
	Fail to inherit processing to FEPCluster custom resource	FEPCluster	Error/Failure in updateing FEPCluster CR with current values
	Start Reflection	FEPCluster	Started patching spec.fepChildCrVal.replicationSlots
	reflection success	FEPCluster	Successfully patching spec.fepChildCrVal.replicationSlots
	Reflection failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.replicationSlots
spec.fep.pgAuditLog	Start Change	FEPCluster	Started update FEPCluster CR
	Succeeded in inheriting processing to FEPCluster custom resource	FEPCluster	Successfully updateing FEPCluster CR with current values

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.fep.pgAuditLog	Fail to inherit processing to FEPCconfig custom resource	FEPCluster	Error/Failure in updateing FEPCconfig CR with current values
	Start Reflection	FEPCconfig	Started patching spec.fep.pgAuditLog
	reflection success	FEPCconfig	Successfully patching spec.fep.pgAuditLog and spec.fep.pgBadger
	Reflection failed	FEPCconfig	Error/Failure in patching spec.fep.pgAuditLog and spec.fep.pgBadger
spec.fep.pgAuditLog.auditLogPath	Start Reflection	FEPCconfig	Started patching spec.fep.pgAuditLog
	reflection success	FEPCconfig	Successfully patching spec.fep.pgAuditLog
	Reflection failed	FEPCconfig	Error/Failure in patching spec.fep.pgAuditLog
spec.fepChildCrVal.customPgAudit	Start Change	FEPCluster	Started update FEPCconfig CR
	Succeeded in inheriting processing to FEPCconfig custom resource	FEPCluster	Successfully updateing FEPCconfig CR with current values
	Fail to inherit processing to FEPCconfig custom resource	FEPCluster	Error/Failure in updateing FEPCconfig CR with current values
	Start Reflection	FEPCconfig	Started patching spec.fepChildCrVal.customPgAudit
	reflection success	FEPCconfig	Successfully patching spec.fepChildCrVal.customPgAudit so restart DB
	Reflection failed	FEPCconfig	Error/Failure in patching fepStatus to patch spec.fepChildCrVal.customPgAudit
spec.fepChildCrVal.customPgHba	Start Change	FEPCluster	Started update FEPCconfig CR
	Succeeded in inheriting processing to FEPCconfig custom resource	FEPCluster	Successfully updateing FEPCconfig CR with current values
	Fail to inherit processing to FEPCconfig custom resource	FEPCluster	Error/Failure in updateing FEPCconfig CR with current values
	Start Reflection	FEPCconfig	Started patching spec.fepChildCrVal.customPgHba
	reflection success	FEPCconfig	Successfully patching spec.fepChildCrVal.customPgHba
	Reflection failed	FEPCconfig	Error/Failure in patching spec.fepChildCrVal.customPgHba
spec.fepChildCrVal.customPgParams	Start Change	FEPCluster	Started update FEPCconfig CR

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
	Succeeded in inheriting processing to FEPCConfig custom resource	FEPCluster	Successfully updateing FEPCConfig CR with current values
	Fail to inherit processing to FEPCConfig custom resource	FEPCluster	Error/Failure in updateing FEPCConfig CR with current values
	Start Reflection	FEPCConfig	Started patching spec.fepChildCrVal.customPgParams
	reflection success	FEPCConfig	Successfully patching spec.fepChildCrVal.customPgParams
	Reflection failed	FEPCConfig	Error/Failure in patching spec.fepChildCrVal.customPgParams
spec.fepChildCrVal.backup.image	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.image
	Change Successful	FEPCluster	Successfully patching febackup spec.fepChildCrVal.backup.image
	Change Failed	FEPCluster	Error/Failure in patching febackup spec.fepChildCrVal.backup.image
spec.fepChildCrVal.backup.mcSpec	Start Change	FEPCluster	Started patching febackup spec.fepChildCrVal.backup.mcSpec
	Change Successful	FEPCluster	Successfully patching febackup spec.fepChildCrVal.backup.mcSpec
	Change Failed	FEPCluster	Error/Failure in patching febackup spec.fepChildCrVal.backup.mcSpec
spec.fepChildCrVal.backup.schedule.num	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule.num
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup
spec.fepChildCrVal.backup.pgbackrestKeyParams	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.pgbackrestKeyParams
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup
spec.fepChildCrVal.backup.pgbackrestParams	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.pgbackrestParams
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup
spec.fepChildCrVal.backup.schedule1	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule1

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup.schedule1
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup.schedule1
spec.fepChildCrVal.backup.schedule2	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule2
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup.schedule2
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup.schedule2
spec.fepChildCrVal.backup.schedule3	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule3
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup.schedule3
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup.schedule3
spec.fepChildCrVal.backup.schedule4	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule4
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup.schedule4
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup.schedule4
spec.fepChildCrVal.backup.schedule5	Start Change	FEPCluster	Started patching spec.fepChildCrVal.backup.schedule5
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.backup.schedule5
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.backup.schedule5
spec.fepChildCrVal.autoscale	Start Change	FEPCluster	Started patching spec.fepChildCrVal.autoscale
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.autoscale
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.autoscale
spec.fepChildCrVal.storage	Start Change	FEPCluster	Started patching FEPVolume CR
	Change Successful	FEPCluster	Successfully patching FEPVolume CR with current values
	Change Failed	FEPCluster	Error/Failure in patching FEPVolume CR with current values
spec.fepChildCrVal.sysUsers	Start Change	FEPCluster	Started patching spec.fepChildCrVal.sysUsers passwords
	Change Successful	FEPCluster	Successfully patching spec.fepChildCrVal.sysUsers in FEPCluster
	Change Failed	FEPCluster	Error/Failure in patching spec.fepChildCrVal.sysUsers in FEPCluster

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.fepChildCrVal.sysUsers.pgMetricsPassword	Start Change	FEPCluster	Started setting spec.fepChildCrVal.sysUsers.pgMetricsPassword to FEPCluster where spec.fepChildCrVal.sysUsers.pgMetricsPassword is undefined
	Change Successful	FEPCluster	Successfully setting spec.fepChildCrVal.sysUsers.pgMetricsPassword
	Change Failed	FEPCluster	Error/Failure in Setting spec.fepChildCrVal.sysUsers.pgMetricsPassword
spec.fepChildCrVal.sysUsers.pgMetricsUserTls	Start Change	FEPCluster	Started setting spec.fepChildCrVal.sysUsers.pgMetricsUserTls to FEPCluster where spec.fepChildCrVal.sysUsers.pgMetricsUserTls is undefined
	Change Successful	FEPCluster	Successfully setting spec.fepChildCrVal.sysUsers.pgMetricsUserTls
	Change Failed	FEPCluster	Error/Failure in setting spec.fepChildCrVal.sysUsers.pgMetricsUserTls
spec.fepChildCrVal.sysUsers.pgMetricsUser	Start Change	FEPCluster	Started delete spec.fepChildCrVal.sysUsers.pgMetricsUser
	Change Successful	FEPCluster	Successfully setting spec.fepChildCrVal.sysUsers.pgMetricsUser or spec.fepChildCrVal.sysUsers.pgMetricsUserTls
	Change Failed	FEPCluster	Error/Failure in setting spec.fepChildCrVal.sysUsers.pgMetricsUser or spec.fepChildCrVal.sysUsers.pgMetricsUserTls
spec.fepChildCrVal.sysUsers.pgMetricsUserTls	Start Change	FEPCluster	Started delete spec.fepChildCrVal.sysUsers.pgMetricsUserTls
spec.fepChildCrVal.sysUsers.pgMetricsUserTls	Start Change	FEPCluster	Successfully setting spec.fepChildCrVal.sysUsers.pgMetricsUser or spec.fepChildCrVal.sysUsers.pgMetricsUserTls
	Change Successful	FEPCluster	Error/Failure in setting spec.fepChildCrVal.sysUsers.pgMetricsUser or spec.fepChildCrVal.sysUsers.pgMetricsUserTls
spec.sysTde.tdek.targetKeyId	Change Failed	FEPCluster	Started patching spec.sysTde.tdek.targetKeyId
	Start Change	FEPCluster	Successfully patching spec.sysTde.tdek.targetKeyId
	Change Successful	FEPCluster	Error/Failure in patching spec.sysTde.tdek.targetKeyId
spec.sysTde.tdek.kmsDefinition.sslpassphrase	Change Failed	FEPCluster	Started patching spec.sysTde.tdek.kmsDefinition.sslpassphrase
	Start Change	FEPCluster	Successfully patching spec.sysTde.tdek.kmsDefinition.sslpassphrase
	Change Successful	FEPCluster	Error/Failure in patching spec.sysTde.tdek.kmsDefinition.sslpassphrase

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.remoteLogging.image	Change Failed	FEPCluster	Started patching fep-logging-fluent-bit spec.remoteLogging.image
	Start Change	FEPCluster	Successfully patching fep-logging-fluent-bit spec.remoteLogging.image
	Change Successful	FEPCluster	Error/Failure in patching patching fep-logging-fluent-bit spec.remoteLogging
spec.monitoring.fepExporter.authSecret (new)	Change Failed	FEPCluster	Started patching FEPEXporter CR because spec.fepExporter.authSecret or spec.fepExporter.tls details are newly defined
	Start Change	FEPCluster	Successfully patching FEPEXporter CR for spec.fepExporter.authSecret or spec.fepExporter.tls details
	Start Change	FEPCluster	Error/Failure in patching FEPEXporter CR for spec.fepExporter.authSecret or spec.fepExporter.tls details
spec.monitoring.fepExporter.tls (new)	Change Successful	FEPCluster	Started patching FEPEXporter CR because spec.fepExporter.authSecret or spec.fepExporter.tls details are newly defined
	Change Failed	FEPCluster	Successfully patching FEPEXporter CR for spec.fepExporter.authSecret or spec.fepExporter.tls details
spec.monitoring.fepExporter.tls (new)	Change Failed	FEPCluster	Error/Failure in patching FEPEXporter CR for spec.fepExporter.authSecret or spec.fepExporter.tls details
spec.monitoring.fepExporter.authSecret (removed)	Start Change	FEPCluster	Started patching FEPEXporter CR because spec.fepExporter.authSecret details are deleted
	Change Successful	FEPCluster	Successfully patching spec.fepExporter.authSecret
	Change Failed	FEPCluster	Error/Failure in patching spec.fepExporter.authSecret
spec.monitoring.fepExporter.tls (removed)	Start Change	FEPCluster	Started patching FEPEXporter CR because spec.fepExporter.tls details are deleted
	Change Successful	FEPCluster	Successfully patching spec.fepExporter.tls
	Change Failed	FEPCluster	Error/Failure in patching spec.fepExporter.tls
spec.monitoring.fepExporter	Start Change	FEPCluster	Started creating FEPEXporter CR
	Change Successful	FEPCluster	Successfully creating FEPEXporter CR
	Change Failed	FEPCluster	Error/Failure in Creating FEPEXporter CR

C.2 FEPEXporter Event Notification on Custom Resource Changes

When "spec.fepExporter.sysExtraEvent" is true, provides event notification of operator actions when the value of the following fields defined in the FEPEXporter custom resource are changed.

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.fepExporter.restartRequired	Start Change	FEPExporter	Started patching spec.fepExporter.restartRequired
	Change Successful	FEPExporter	Successfully patching spec.fepExporter.restartRequired
	Change Failed	FEPExporter	Error/Failure in patching spec.fepExporter.restartRequired
spec.fepExporter.userCustomQueries	Start Change	FEPExporter	Started patching spec.fepExporter.userCustomQueries
	Change Successful	FEPExporter	Successfully patching spec.fepExporter.userCustomQueries
	Change Failed	FEPExporter	Error/Failure in patching spec.fepExporter.userCustomQueries

C.3 Event Notification When FEPLogging Custom Resource Changes

When "spec.fepLogging.sysExtraEvent" is true, provides event notification of operator actions when you change the value of the following fields defined in the FEPLogging custom resource.

Field Whose Value You Want to Change	Notification Timing	Notification Custom Resources	Notification Message
spec.fepLogging.restartRequired	Start Change	FEPLogging	Started patching spec.fepLogging.restartRequired
spec.fepLogging.restartRequired	Change Successful	FEPLogging	Successfully patching spec.fepLogging.restartRequired
spec.fepLogging.restartRequired	Change Failed	FEPLogging	Error/Failure in patching spec.fepLogging.restartRequired
spec.fepLogging.scrapeInterval spec.fepLogging.scrapeTimeout	Start Change	FEPLogging	Started patching spec.fepLogging.scrapeInterval and spec.fepLogging.scrapeTimeout
spec.fepLogging.scrapeInterval spec.fepLogging.scrapeTimeout	Change Successful	FEPLogging	Successfully patching spec.fepLogging.scrapeInterval and spec.fepLogging.scrapeTimeout
spec.fepLogging.scrapeInterval spec.fepLogging.scrapeTimeout	Change Failed	FEPLogging	Error/Failure in patching spec.fepLogging.scrapeInterval and spec.fepLogging.scrapeTimeout
spec.fepLogging.restartRequired	Start Change	FEPLogging	Started patching spec.fepLogging.restartRequired